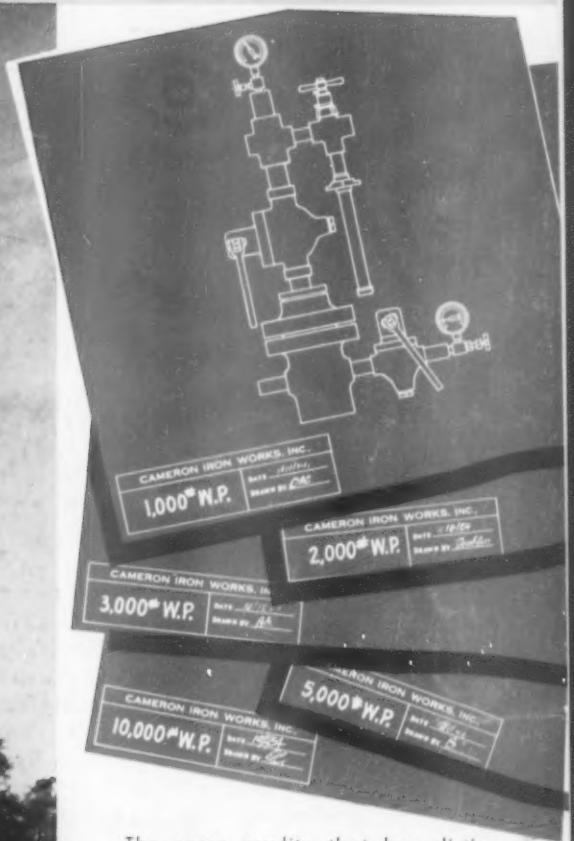
the OIL AND GAS JOURNAL

A.P.I. NUMBER

Levi Reynolds, Cameron's Division Manager, Oklahoma Division



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Best wishes to — AD

PRICE 50 CENTS TABLE OF CONTENTS ON PAGE 1 **NOVEMBER 15, 1954**

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SERVES CUSTOMERS *GAS* DIRECT FROM HIGH PRESSURE PIPE LINES

High pressure is no barrier to serving individual farms, ranches and small industries from your transmission lines. The double reduction system in this Rockwell farm tap "package" assures a high safety factor since both primary regulators are designed to handle the full line pressure. By dividing the regulating load, heavy mechanical stresses, valve abrasion and scoring of seats are eliminated.

The Rockwell "175" high pressure meter is especially designed for this service. The case is tested for 50 psi working pressure. This meter can be optionally furnished with either a standard index or compensating indexes for 10 psi or 50 psi measurement. *Write for full details and prices.*

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   . . . makes the primary cut from 1000 psi or less to an outlet pressure of 100 psi.

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   . . . makes the secondary pressure cut; feeds gas to the Rockwell "175" meter at 10 psi.

4. **ROCKWELL "175" HIGH PRESSURE METER**
   . . . has 10 psi compensating index. Will operate with complete safety at 50 psi.

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   . . . located at the dwelling, makes the final pressure cut to inches of water.

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the OIL AND GAS JOURNAL NOVEMBER 15, 1954 VOL. 53 NO. 28

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In Brief . . .

This, the Journal's annual A.P.I. number, is largely devoted to the annual meeting of A.P.I., held November 8-11 in Chicago. Featured are:

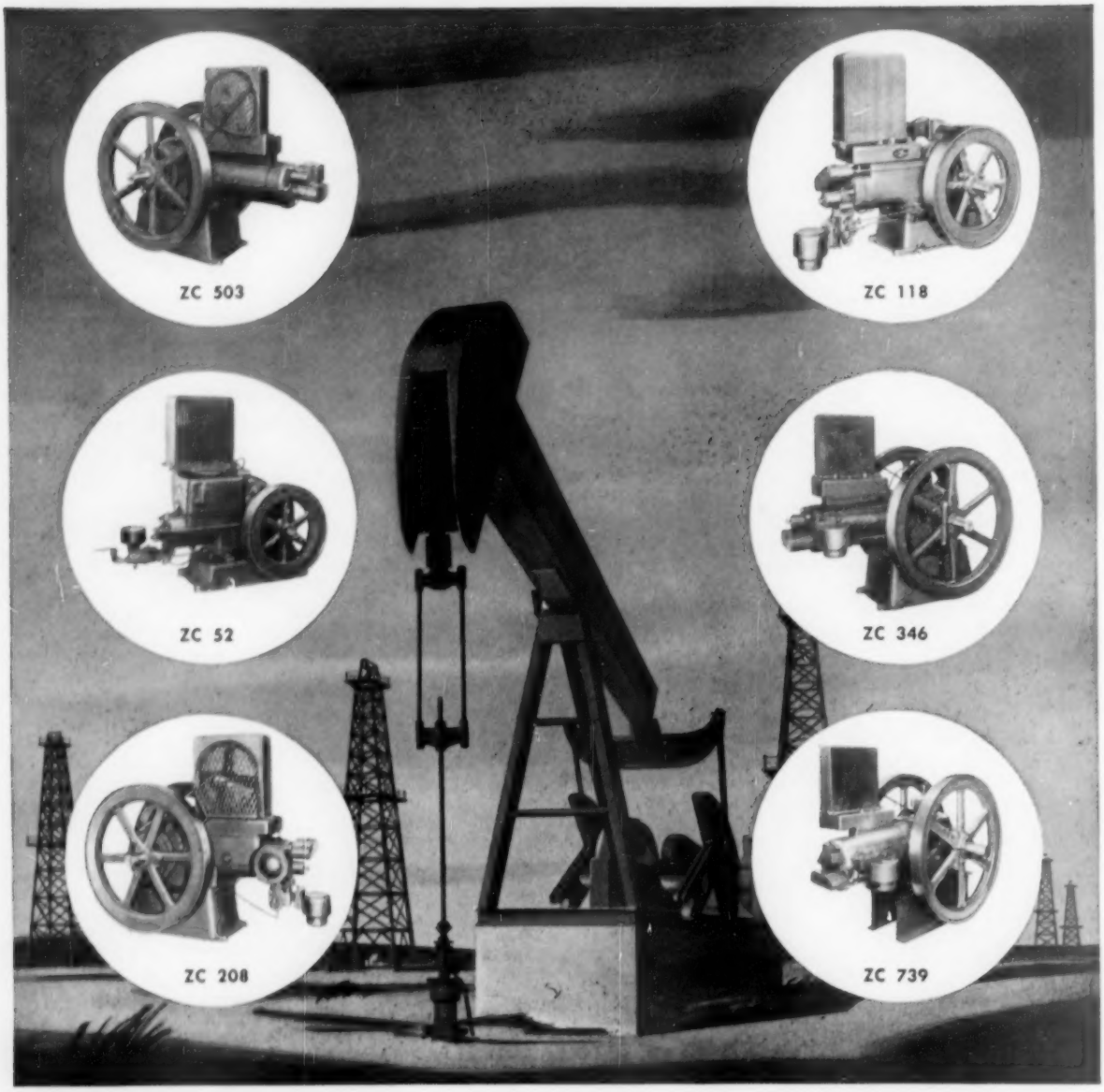
• **Spot news coverage.** Six members of the editorial staff, along with a number of other Journal employes, were at the meeting to provide full coverage. The result is a 14-page section, complete with pictures, which mirrors the significance of the whole meeting and its various facets.

• **Selected papers.** Fourteen of the most significant papers presented at the meeting are printed in full. These articles cover activities in all the various branches of the oil industry.

Several articles are devoted to recent advances in pipeline technology. These include filtering practices in product pipelines, control of corrosion in sour-crude tanks, calculating pressure drop in oil pipelines, standards for radiographic inspection of pipeline welds, and the effect of bending pipeline sections.

Three articles are concerned with problems in bulk-oil measurement. One deals with present practices and improvements that can be expected in the near future. Another predicts future developments in the field and shows the trend to increased automation. The third sums up management's views on the problem.

• **A.P.I. research reports.** Detailed summaries are given on seven active A.P.I. research projects. In the report on each project, a brief summary of past work is given. The scope and significance of present work are fully explained. Finally, the paths and patterns of future work are outlined.



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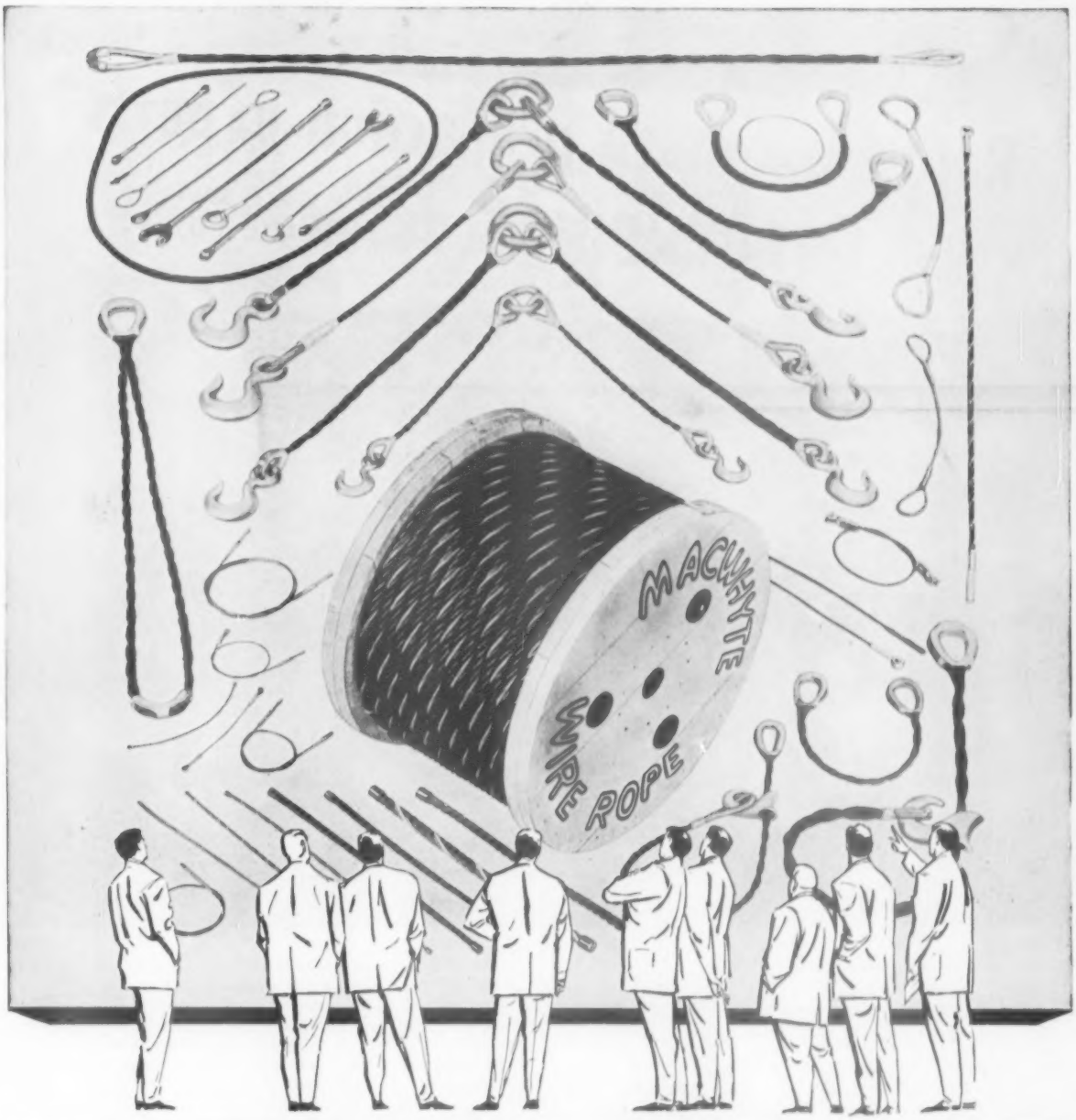

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HI-BRIN . . . is "Oilwell's" new special-alloy pump barrel for all depth wells where abrasion and high hydrogen sulphide corrosion are found. Our exclusive Nitrocycle bore-hardening process results in extreme hardness and permits exceptionally accurate bores over long lengths.

DI-HARD . . . in SECTIONAL LINER and FULL BARREL construction is unexcelled for deep well pumping. This material resists extreme carbon dioxide as well as hydrogen sulphide corrosion. Its low coefficient of friction resists abrasion and permits the use of metal-to-metal DI-HARD plungers which maintain uniform clearances under temperature changes, and minimize electrolytic corrosive action. Exclusive locking rings on DI-HARD sectional liners permit jacketed assemblies in pump lengths to 30 feet and over.

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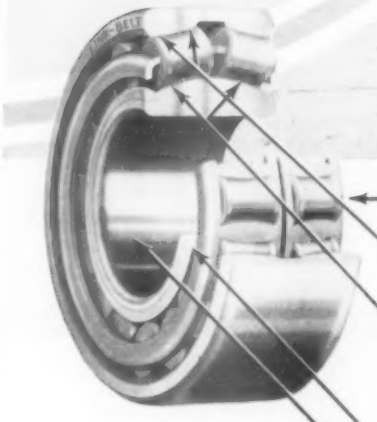
THIS portable spudder gets rough usage, whether it's used for exploration or production drilling. To provide dependable and efficient bearing operation for this demanding service, the designers at Walker-Neer Manufacturing Company, selected Link-Belt self-aligning roller bearings.

The inherent self-aligning feature of these precision bearings insures free-rolling, high efficiency, even with shaft deflection or misalignment. The angular position of concave rollers between convex raceways, provides capacity for radial thrust, or combination radial-thrust loads.

You can get full details on Link-Belt's complete bearing line from the Link-Belt bearing engineer in your area. Call him today, or write for Data Book 2550.



ROLLERS ARE COMPLETELY POCKETED in hardened steel retainers for accurate spacing and guiding.

NO PINCHING OR BINDING — Symmetrical rollers are naturally positioned by their concave shape, assuring free rolling and eliminating end friction.

INTEGRAL SELF-ALIGNMENT — Angular contact of concave rollers operating between convex raceways. Inner raceway free to align angularly in any direction.

FULL LOAD CAPACITY for radial, thrust or combined radial-thrust loads is assured even with shaft deflection or misalignment.

PROPER CLEARANCE of all parts is built-in, and bearing is locked together as a complete assembly.

STRAIGHT BORE MOUNTING for press fit direct on shafting. Tapered adapter sleeve also available for use with commercial shafting where easy removal and installation of bearings are advantageous.

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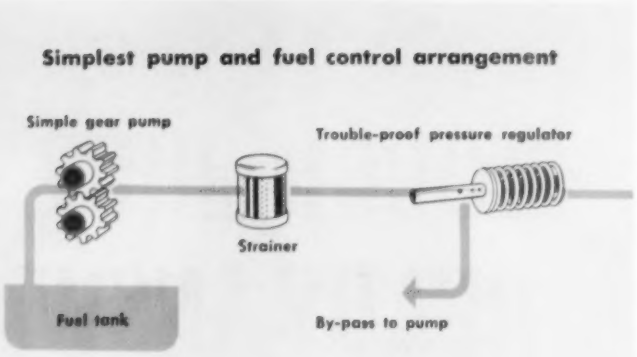
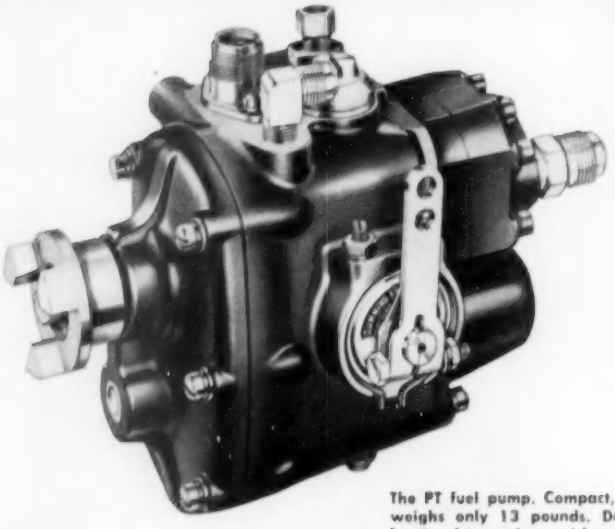
Here's the simplest diesel fuel system ever developed!



Cummins new PT *fuel system...*

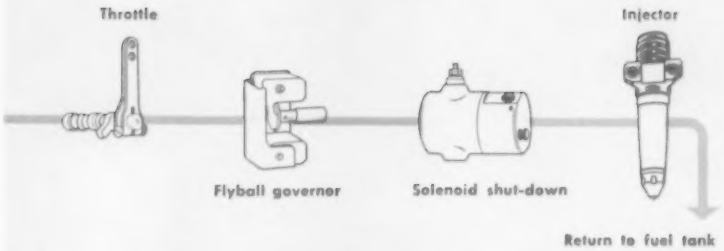


The PT fuel pump. Compact, easy to handle, weighs only 13 pounds. Does not have to be timed to engine, quick and easy to install.

The PT injector utilizes the exclusive Cummins principle of fuel injection which has set the highest standards of performance and economy for more than 20 years.

THE revolutionary new PT fuel system, now standard on all Cummins Diesels, has fewer and far simpler parts than carburetor and ignition systems or ordinary diesel fuel systems. It is easy to understand, simple to work with, can be serviced by any mechanic. No longer any need for fuel system specialists! The PT fuel system has undergone two years of field testing and millions of operating miles under every conceivable condition. Its dependability record is phenomenal. Operators report even less fuel consumption than with earlier Cummins fuel systems and far less cost of maintenance. The PT fuel system can be installed on any Cummins Diesel built since 1932.

Cummins *leader in lightweight high speed diesel power 60-600 h. p.*



PT advantages over gasoline systems:

No contact points to adjust	No vapor-lock problems
No condenser to replace	No flooding
No spark coil to short	No choking or priming
No wiring harness to short	No needle valves to clog
No spark plugs	No butterfly valve
	No float level to maintain
	No float valve to stick

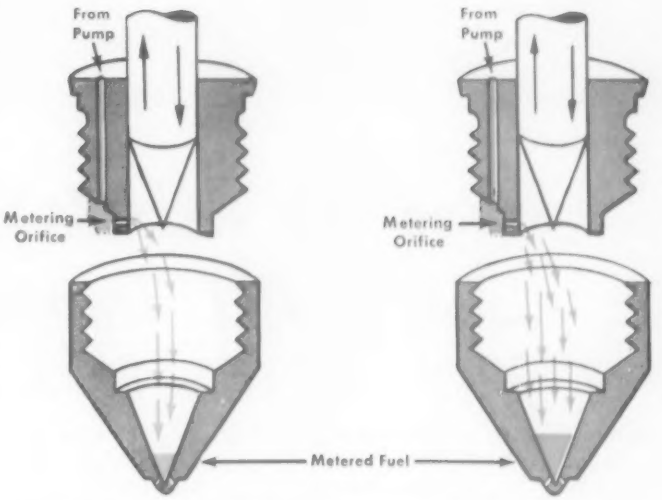
PT advantages over ordinary diesel systems:

No fuel rack adjustments	No distributor discs
No check valves	No metering pumps
No needle valves	No high-pressure fuel lines
No helixes	No fuel pump timing

... simpler to work with than gasoline carburetion and ignition

Simplest Fuel Metering Device

The principle is simply that the amount of fuel flowing through a fixed orifice varies according to the amount of pressure on the fuel. Pressure is controlled by the throttle on the PT pump. Fuel flow through orifice is cut off as injector plunger, actuated by engine camshaft, moves down to inject fuel.



When engine is under partial load, fuel pressure is low, and only a small amount of fuel passes through orifice into injector cup.

When engine is under full load, fuel pressure is increased, and greater amount of fuel passes through orifice into injector cup.

Mail this today, and get more PT facts!

CUMMINS ENGINE COMPANY, INC. DEPT. OG-11
Columbus, Indiana

Please send me free illustrated folder, "Cummins PT Fuel System."

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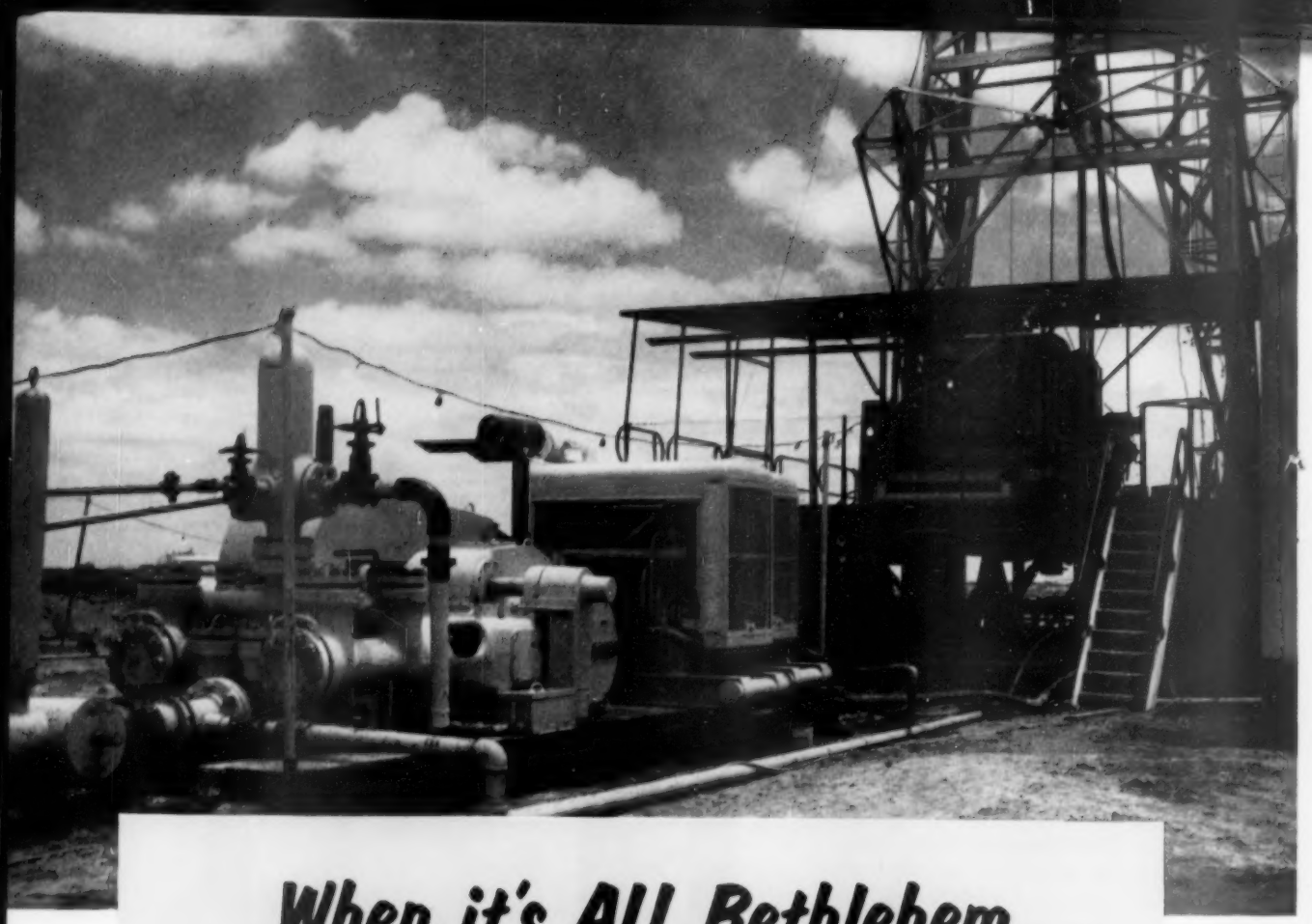

When it's ALL Bethlehem ...it's ALL Dependable

Whenever a customer describes his Bethlehem rig as "dependable"—that's the highest praise he can give us. For all our years of research, all the engineering at our command, all the production steps in our shops are directed toward just one end—dependable performance of Bethlehem machines.

It's a comfortable feeling to know that your rig will keep going at 12,000, 15,000, 18,000 feet when the chips are down and the stakes are high. With a rig wholly built and equipped by Bethlehem, you have that assurance, as many an owner will tell you. Every Bethlehem component is a dependable item of equipment. When the rig is all Bethlehem, it's *all* dependable. There are no mismatched elements; everything is in balance, everything precision-engineered.

Bethlehem rigs are fast drillers and they are conservatively rated, with high reserve. But that's not the most important thing. They are dependable under any conditions of operation; that *is* the most important thing.

So, make it Bethlehem from crown block to the bottom of the hole. No matter what sort of drilling you do—shallow, medium, deep—there are Bethlehem drawworks, slush pumps, swivels, rotary tables and everything else for your particular set-up. Ask for complete details; we'll gladly spend all the hours or days you want, talking it over with you.

In addition to drilling equipment and a full range of pumping units, Bethlehem offers Beth-Co-Weld line pipe, Purple Strand wire rope, and a complete variety of sucker rods, fasteners, etc. Ask for these reliable products when equipping your oil-country installations.

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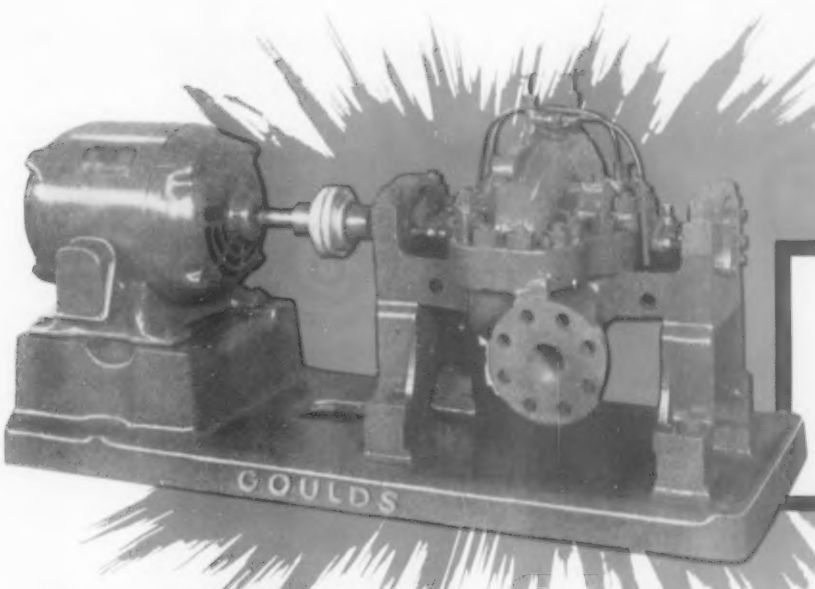


announcing...

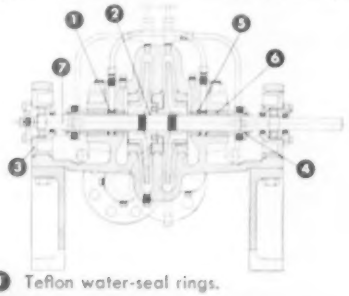
the Goulds Fig. 3305 two-stage, opposed impeller pump for clear liquids. 5 sizes. Capacities to 1200 GPM. Heads to 1000 ft.

This new Goulds pump offers you 5 specific operating and maintenance advantages . . .

To reduce your liquid-handling costs through greater standardization, easier maintenance, and improved operating characteristics, Goulds engineers have developed the *new* Goulds Fig. 3305 two-stage, opposed impeller centrifugal pump. Here are the highlights—the result of 50 years concentration on industry's centrifugal pump needs.

1 High operating efficiency, low maintenance cost

The Fig. 3305 pump combines the seven features indicated on the sectional drawing below to contribute a quality of dependable service which adds up to true operating and maintenance economy.



1. Teflon water-seal rings.
2. Stainless steel impeller key.
3. Bearing housing sealed against moisture and dirt.
4. Cowl-type glands suitable for use with quenching liquids.
5. Renewable stuffing box bushings.
6. Die-formed stuffing box packing.
7. Corrosion-resistant gland bolts.

2 Reduces your spare parts inventory

Only two shaft and rotating parts assemblies provide for 5 pump sizes and 10 pump combinations. This means a remarkable range of parts interchangeability which you will find detailed on page 7 of the descriptive bulletin. Furthermore, most of the components of the Fig. 3305 shaft and rotating assemblies are interchangeable in the Fig. 3405 single-stage, double-suction pump which has won industry-wide acceptance in the year since it was introduced.

This high degree of standardization helps materially to reduce spare parts inventories. It also gives you great flexibility in adapting your Fig. 3305 pump to changing field requirements.

3 Saves space

The short bearing span of Fig. 3305 pumps means considerable saving in floor space—as much as 50% in some comparisons with conventional designs of comparable capacity and head.

4 Stuffing box to match your requirements

You can choose either a conventional stuffing box with gland or a mechanical seal, according to your need. And you can easily change from one to the other at any time.

5 Simple to change rotation

A patented locking device makes it easy to change the rotation of this pump from right-hand to left-hand or vice versa *in the field and without additional parts.*

Before you select another pump for handling clear liquids at rates up to 1200 GPM and heads to 1000 ft., be sure you have the detailed cost-advantage story of Goulds new Fig. 3305 pump. We'll send you descriptive bulletin—promptly on request.

Get the complete story—This 12-page illustrated Bulletin No. 722.6, covers the new Goulds Fig. 3305 pump completely. It gives specifications, interchangeability tables, performance curves, dimensions.

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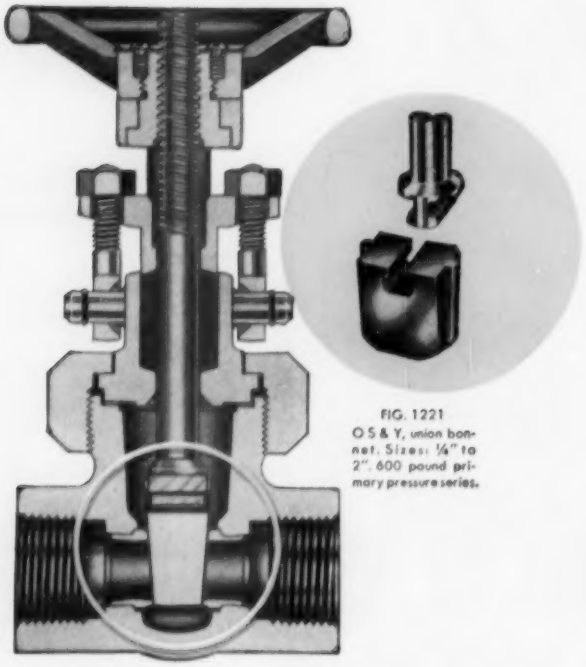

FIG. 1221
O S & Y, union bonnet. Sizes: ¼" to 2". 600 pound primary pressure series.

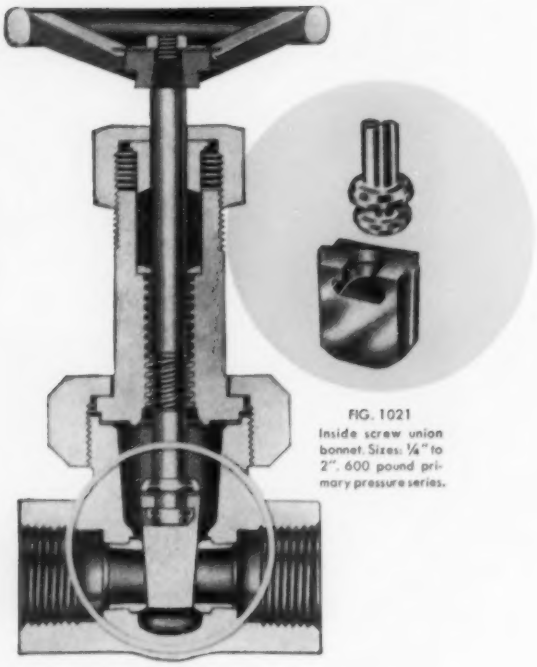

FIG. 1021
Inside screw union bonnet. Sizes: ¼" to 2". 600 pound primary pressure series.

New design makes OIC forged steel gate valves the most modern line . . .

NEW: stronger stem-to-wedge connection. Improved, modern design increases pull-out strength to many times the theoretical requirement. This design distributes the pull-out load more efficiently throughout the wedge structure to meet the most stringent specifications of valve buyers in all fields.

NEW: wedges wear longer. Wedges are made of 13% chrome stainless steel for corrosion resistance. They are duracased to at least 1000 Brinell Hardness to prevent galling and excessive wear caused by frequent closures upon foreign particles in the flow.

NEW: union bonnet design is more efficient. Body-to-bonnet joint of the male-female type provides a recess for the gasket. It is contained more securely, reducing the possibility of leakage or a blown gasket.

OTHER OUTSTANDING FEATURES

Stem threads of all OIC inside screw, forged steel valves are always contained inside the bonnet. They can't possibly load up with corrosive matter which might be in the flow. This keeps the threads clean and free running, and contributes to longer stem wear.

Modern OIC Seal-Ever packing is a special composition which eliminates electrolytic action between the stem and the packing. This prevents stem corrosion in the packing area and helps maintain a leakproof seal.

Back-seating feature provides means of repacking valves while in service.

OS & Y valve gland "I" bolts are retained on trunnions by modern, more efficient, stainless steel snap rings.

Shoulder-type seat rings are expanded into the body under heavy pressure. They are accurately machined to mate tightly with the wedge for a positive seal.

Order modern OIC Forged Steel Valves from your nearby OIC Distributor. Write and request Folder No. 195.

OIC Forged Steel Valves are also available in globes, angles and checks in a variety of trims for any service.

THE OHIO INJECTOR COMPANY • WADSWORTH, OHIO

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YOU SAVE three important ways when you specify TUBE-TURN Welding Fitting and Flanges. (1) You get the most advanced products available . . . assured by Tube Turns' pioneering research. (2) You get the exact fitting and flange for *your* problem promptly because Tube Turns has the world's most complete line . . . available nearby. (3) You get piping ideas through the outstanding Engineering Service and how-to-do-it information of Tube Turns.

These money-saving extras are yours when you specify "TUBE-TURN". Call your nearby Tube Turns' Distributor.

The Leading Manufacturer of Welding Fittings and Flanges

TUBE TURNS LOUISVILLE 1, KENTUCKY

A Division of National Cylinder Gas Company

DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Cleveland • Chicago • Denver • Los Angeles
San Francisco • Seattle • Atlanta • Tulsa • Houston • Dallas • Midland, Texas

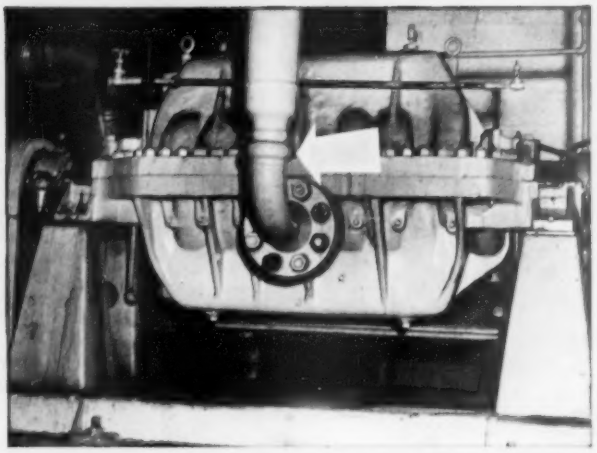
SEE HOW YOU SAVE

TUBE TURNS'
Engineering Service
helps save $50,000

A LARGE PROCESSOR had a problem of retubing seven large cooling units, formerly fabricated from copper tubing and fittings. Thin-walled aluminum was considered as a replacement; however, there were no satisfactory methods for fabricating the metal.

Tube Turns' Engineering Service Division, working with Alcoa, came up with the solution. Special TUBE-TURN Elbows and a new brazing technique were developed and the problem was solved. Total saving by customer was $50,000. This engineering service is one of the extras you get when you do business with the leader . . . Tube Turns.

THE JOB. Brazing TUBE-TURN Aluminum Returns to aluminum tubing for cooling coils.



NEW HYDRAULIC COUPLING. This unique new TUBE-TURN Coupling for hydraulic piping eliminates weld scale and protrusions at joints, protects pumps and other precision equipment for lowest-cost operation. You are sure to get the latest cost-saving developments in fittings and flanges when you specify "TUBE-TURN".

YOU GET COMPLETE SERVICE. Your nearby Tube Turns' Distributor gives you the *exact* answer to your specific piping problem from the world's most complete line of welding fittings and flanges. It includes more than 4000 items . . . in all piping materials, schedules and sizes. This service is backed up by Tube Turns' engineering assistance.

Information . . . new 76-page booklet compiles data on many phases of piping application. This booklet, "Allowable Working Pressures" is yours for the asking. Just mail the coupon.

TUBE TURNS, Dept. J-6
224 East Broadway • Louisville 1, Kentucky

Please send free copy of booklet, "Allowable Working Pressures".

Company Name _____

Company Address _____

City _____ *Zone* ____ *State* _____

Your Name _____

Position _____

DISTRICT OFFICES

New York	San Francisco
Philadelphia	Seattle
Cleveland	Atlanta
Chicago	Tulsa
Denver	Houston
Los Angeles	Dallas
Midland, Texas	

"tt" and "TUBE-TURN" Reg. U.S. Pat. Off

TUBE TURNS

LOUISVILLE 1, KENTUCKY

A DIVISION OF NATIONAL CYLINDER GAS COMPANY

ELIMINATES DRILLING-OUT OF TOOL IN SQUEEZE JOBS

HALLIBURTON'S *RETRIEVABLE* CEMENTER

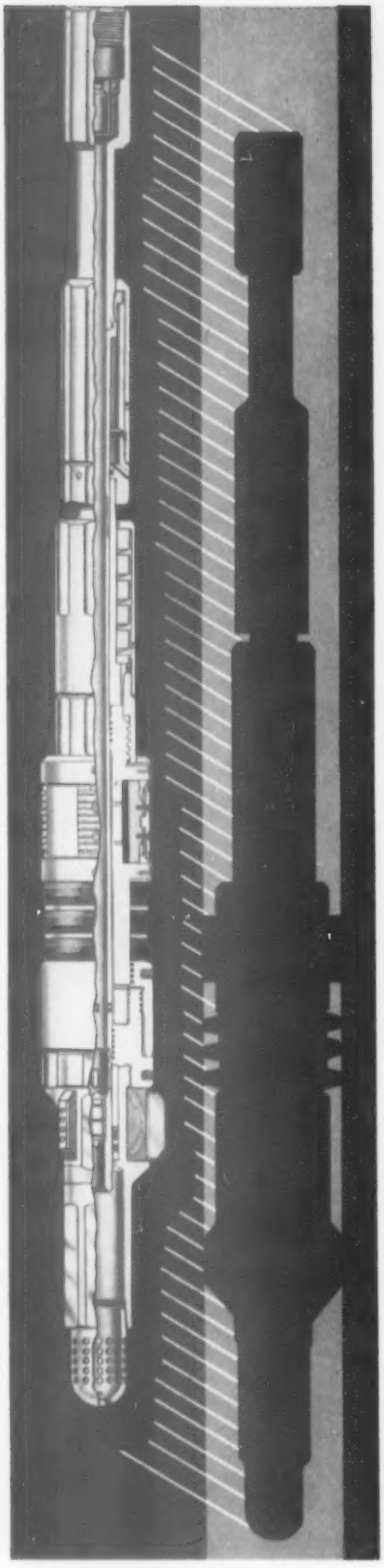
The speed you need for economical squeezing and other remedial work is built right into the Halliburton Retrievable Cementer—the one dependable tool that can complete *all* the work in *one* fast round trip and save you hours of costly rig time.

The Cementer is retrieved usually within an hour after cement is placed. There's no metal left to be drilled out. This saving plus the consistently successful operation of the Retrievable Cementer makes it the most popular tool for remedial work under normal cementing pressures and well conditions.

You'll save hours and still get better production protection on all these jobs—testing and repairing casing leaks; recementing casing around shoe; recementing liners; remedying high gas/oil ratios; controlling or shutting off unwanted water; correcting channeling behind casing; supplementing primary cement jobs; acidizing through perforated zones; and spotting chemicals for removing paraffin or Securaloy windows.

The set-release-reset action of the Cementer permits testing and squeezing operations—as many times as needed and wherever needed—to be performed without ever bringing the tool out of the hole. As soon as all work is completed, the Cementer is retrieved and you're back on production hours sooner than with conventional tools that require drilling-out.

Use the Retrievable Cementer on your next job. You'll find the one trip, dependable operation will mean lower costs, higher production and better protection. Call your local or district Halliburton office. Or contact Halliburton Oil Well Cementing Company, Duncan, Oklahoma.



HALLIBURTON

CEMENTING SERVICES

THERE'S NO SUBSTITUTE FOR EXPERIENCE IN OIL WELL CEMENTING

THE GREATEST SHOWING OF INDUSTRIAL RUBBER PRODUCTS ON EARTH
REPUBLIC RUBBER
WIRETEX
HP STEAM
YOUNGSTOWN, OHIO
1. Special heat-resistant cover compound, firmly bonded to carcass.
2. Non-charring asbestos cords interbraided with wires which dissipate static electricity.
3. High adhesion between plies provided by special insulative compound.
4. Steel wires of high-tensile strength braided to resist high steam pressures and make hose Burst-Proof.
5. Heat- and oil-resisting inner tube retains resiliency under high-pressure steam.

SAFETY IS YOUR CONCERN!

Your employees rightfully expect you to furnish them with the Safest tools available . . . including Steam Hose that Will Not Burst!

WIRETEX Steam Hose **will not burst . . can not** suddenly spray out super-heated steam, blinding steam, maiming steam; yes, even killing steam.

For what you are now paying for ordinary steam hose, you can insist upon getting WIRETEX Steam Hose . . . with a Safety Factor far beyond that provided by ordinary steam hose specifications.

Ask your local Republic Rubber Distributor. If his name is not listed in the yellow pages of your telephone directory, write directly to us.

MID-CONTINENT DISTRIBUTOR
Jones & Laughlin Steel Corporation, Supply Division
P. O. Drawer 2481, Tulsa 2, Okla.

REPUBLIC RUBBER DIVISION
LEE RUBBER & TIRE CORPORATION, YOUNGSTOWN 1, OHIO
INDUSTRIAL RUBBER PRODUCTS

WEST COAST DISTRIBUTORS
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Pacific Coast Rubber Company
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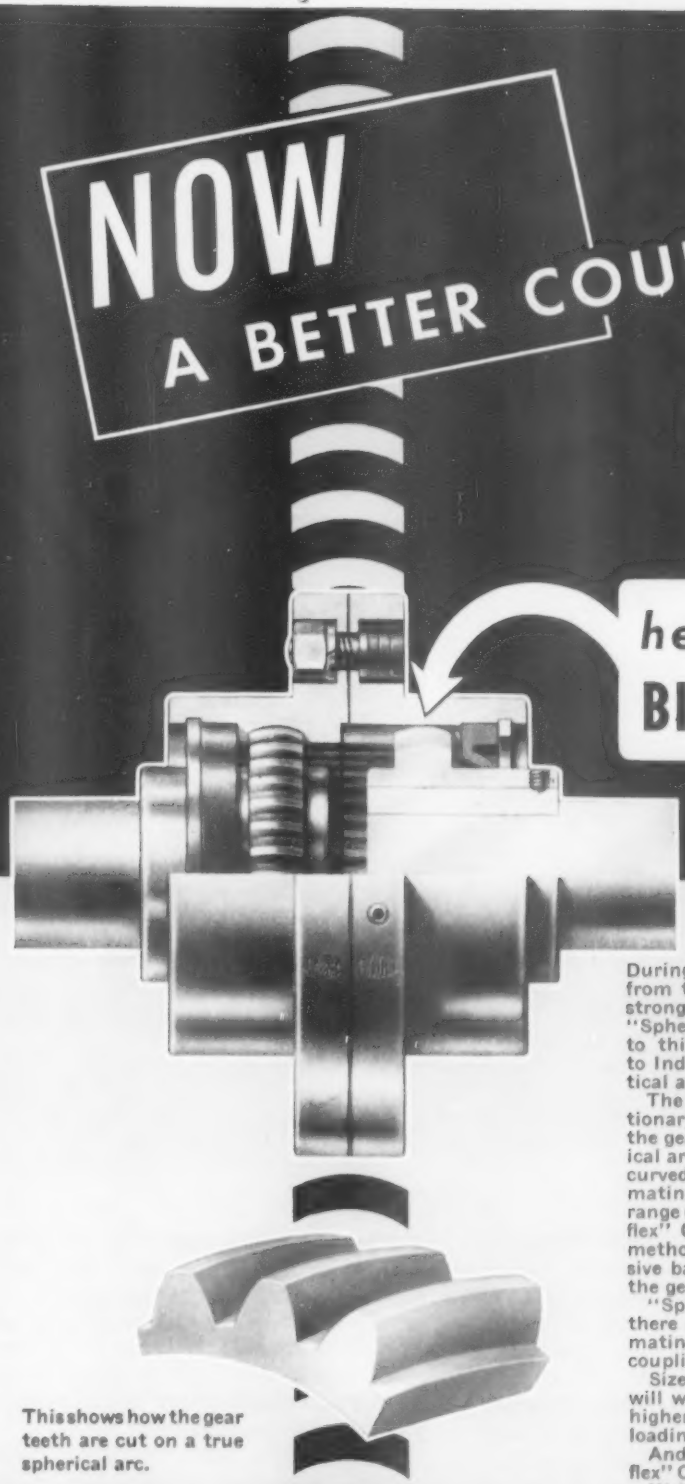
NOW A BETTER COUPLING SPHEREFLEX

here's the BIG DIFFERENCE



This shows how the gear teeth are cut on a true spherical arc.

During recent years there has been a demand from the Aircraft Industry for a more flexible, stronger Gear Coupling. Although Philadelphia "Sphereflex" Coupling was developed in answer to this special need, it is now being offered to Industry in a complete line of standard, vertical and floating shaft couplings.

The "Sphereflex" Coupling utilizes a revolutionary new principle of coupling design, in that the gear teeth are precision cut on a true spherical arc. Since even the root of the gear tooth is curved, there can be no interference between mating gear teeth, even when shaft deflections range up to 7° total mis-alignment. The "Sphereflex" Coupling is in radical contrast to former methods of obtaining flexibility through excessive backlash or merely chamfering the tips of the gear teeth.

"Sphereflex" is a stronger coupling, because there is always a full line of contact between mating gear teeth, regardless of whether the coupling is flexed or perfectly aligned.

Size for size, the new "Sphereflex" Coupling will withstand more deflection, greater torque, higher rotating speeds, and more severe shock-loading than comparable couplings.

And remember, you pay no more for a "Sphereflex" Coupling than other good quality couplings.

Write for Catalog C-540.

PHILADELPHIA GEAR WORKS, INC.

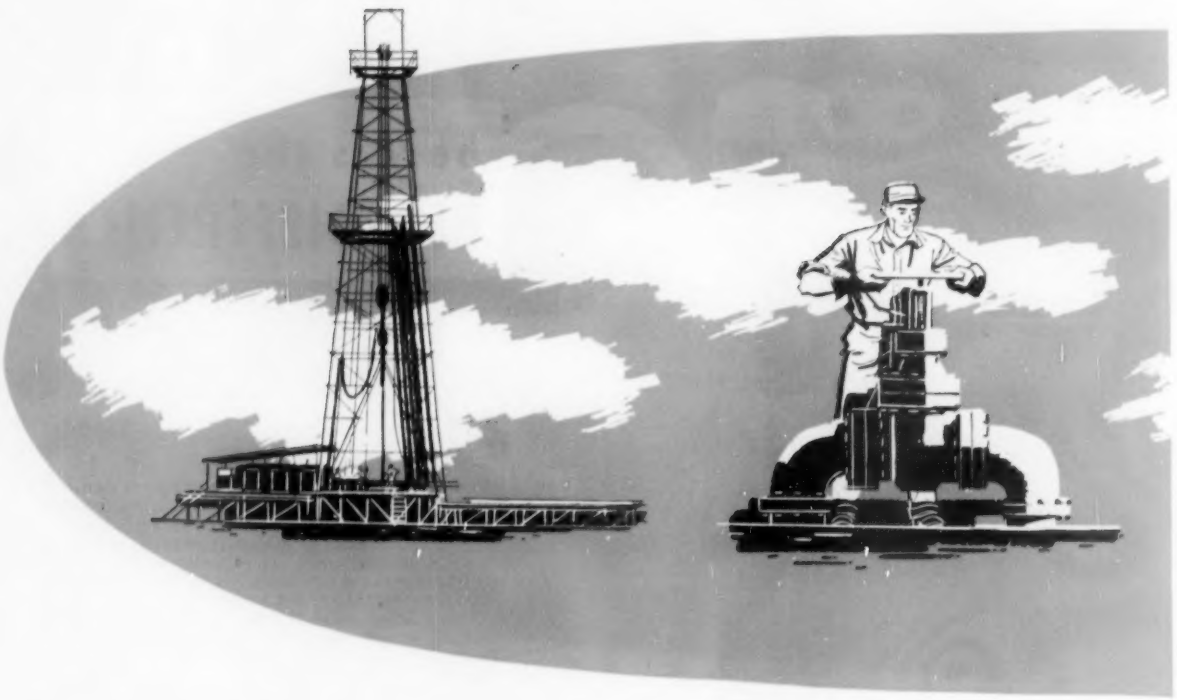
ERIE AVE. AND G ST., PHILADELPHIA 34, PA.
NEW YORK • PITTSBURGH • CHICAGO • HOUSTON • LYNCHBURG, VA.

Industrial Gears & Speed Reducers

LimiTorque Valve Controls

how much can ALCOA

from well to user, Alcoa Aluminum saves money for oil and gas men



ALCOA ALUMINUM INDUSTRIAL BUILDING SHEET has become the favorite lightweight metal for roofing and siding that will stand up in corrosive atmospheres with a minimum of maintenance required.

ALCOA ALUMINUM TREAD PLATE, CONDUIT AND HANDRAILS are also available for use wherever corrosion is a problem.

ALUMINUM PAINT, made of ALCOA Pigments, covers better, lasts longer, costs no more than ordinary paints. That, plus excellent reflective qualities, has made it the most practical, most popular paint in the petroleum industry.

ALCOA ALUMINUM PIPE is particularly economical for construction across rivers, swamps and hilly terrains because aluminum is so light, so easy to handle. Two men can easily handle 40-ft lengths of 8⅝-in. OD pipe.

ALCOA ALUMINUM SHEET is used to weatherproof thermal insulation.

ALCOA ALUMINUM INSTRUMENT TUBING—hundreds of miles of it—are in use throughout the petroleum industry. ALCOA Utilitube® comes in lengths up to 1,000 feet and more . . . costs 40 per cent less than tube made of other corrosion-resistant metals.

FREE — new booklet, *Alcoa Aluminum Heat Exchanger Tubes.* Write for your copy today.

ALUMINUM save you?

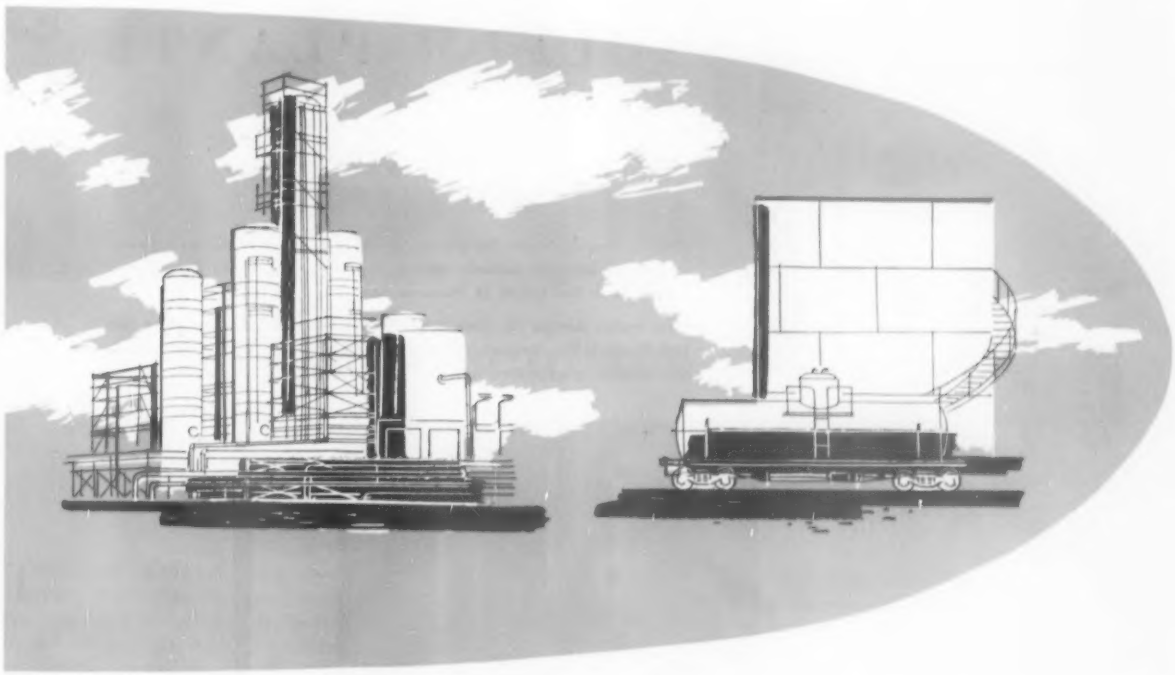
Alcoa Aluminum offers real money savings to the petroleum industry.

It's lower in original cost than other corrosion-resistant metals.

It has excellent low-temperature properties.

It resists corrosion. It's easily worked.

Write today for all the facts.



ALCOA ALUMINUM HEAT EXCHANGER TUBES have been used for more than 20 years, handling sour gasoline stocks. Because ALCOA Aluminum is resistant to hydrogen sulfide, ammonia, carbon dioxide, hydrocarbons and cooling waters, it is ideal for catalytic cracking overhead condensers, compressor intercoolers and aftercoolers.

ALUMINUM BUBBLE CAPS have given service of 10 to 15 years in debutanizer columns, handling gasoline distillate from sour crudes at 200° to 425° F as well as in fractionating columns for sour crude gas oils at 400° to 625° F.

ALUMINUM FORMS FOR MOLTEN SULFUR are used since ALCOA Aluminum has exceptional resistance to sulfur fumes and gaseous compounds.

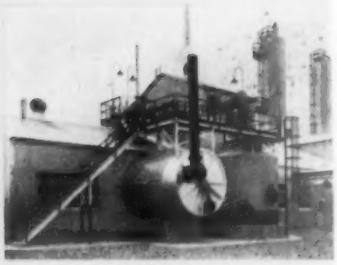
ALUMINUM TANK CARS, used for more than 25 years to transport sensitive products, cost up to ⅛ less than stainless steel cars.

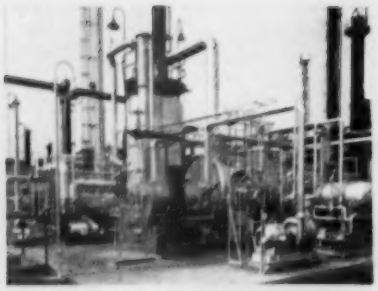
ALUMINUM STORAGE TANK ROOFS for sour crude oils have been in service for more than 22 years in locations where steel roofs failed in less than five years. Internal supporting structure, hatches, vent lines and other fittings are of ALCOA Aluminum.

ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA

904-L Alcoa Building, Pittsburgh 19, Pa.

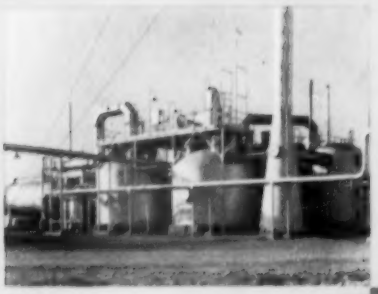




20

SULFUR PLANTS

by... **PARSONS**



75% of the contracts for plants to recover sulfur from H_2S in the United States and Canada during the past two years have been awarded to The Ralph M. Parsons Company.

Now under design for Tide Water Associated Oil Company on the East Coast is the largest sulfur recovery plant ever to be designed. This facility is expected to be on stream in 1956.

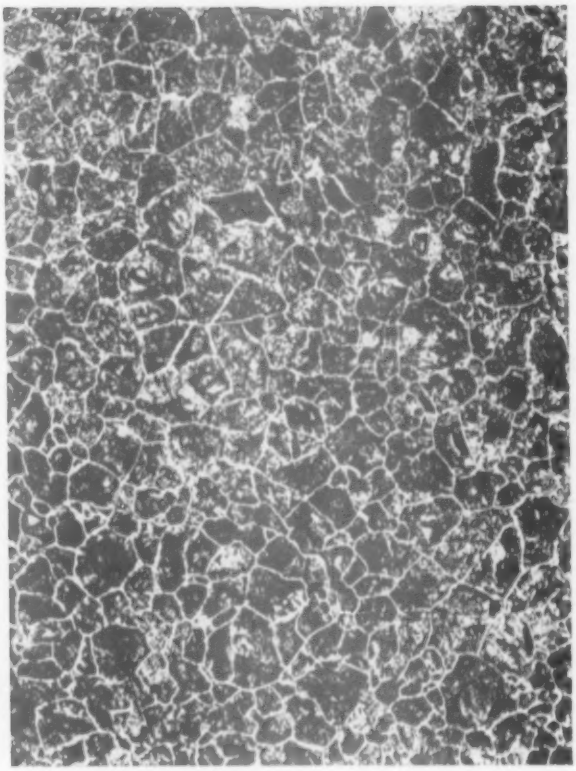
THE RALPH M. PARSONS COMPANY

Engineers • Constructors

617 South Olive Street, Los Angeles 14, California

NEW YORK • TULSA • WASHINGTON • ANKARA • BAGHDAD

BEIRUT • KARACHI • NEW DELHI • PARIS



Meet two of the reasons why TIMKEN® forging steels give you uniform, high-quality forgings

THE man on the left helps assure you of uniform composition in every Timken® steel forging bar. With this spectrometer, he can tell the exact composition of a melt in just 40 seconds. Results are flashed back to the furnace so the melter can maintain constant control of the heat analysis up to the instant of pouring.

The photomicrograph at right shows the uniform grain size of the Timken forging steels. Uniform grain size after heat treatment is assured by spectrometric or microscopic examination of every heat. The result—you can be sure that forgings made from Timken forging steels have uniformly high ductility and resistance to impact.

But that's only part of the story. You can hold rejects to a minimum because we condition the steel to fit your particular forging requirements. And you save steel because the good dimensional tolerances of Timken forging steels produce uniform weight multiples with a minimum of steel lost in flashings. You even have fewer furnace adjustments because Timken forging steels respond uniformly to heat treatment.

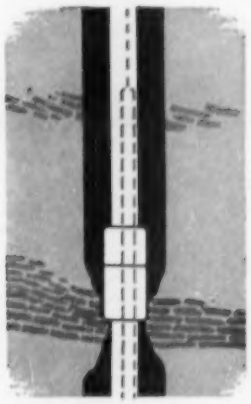
For help in improving the quality of your forgings and cutting production costs, write: The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

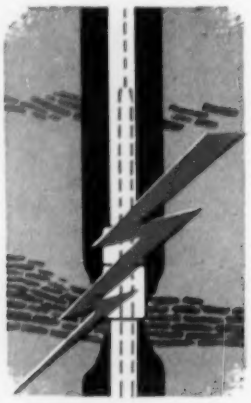
SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING

When you're stuck...

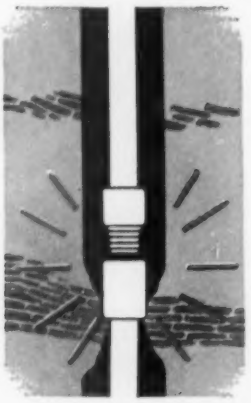
DIA-LOG's *unbeatable combination recovers drill pipe faster than any other method!*



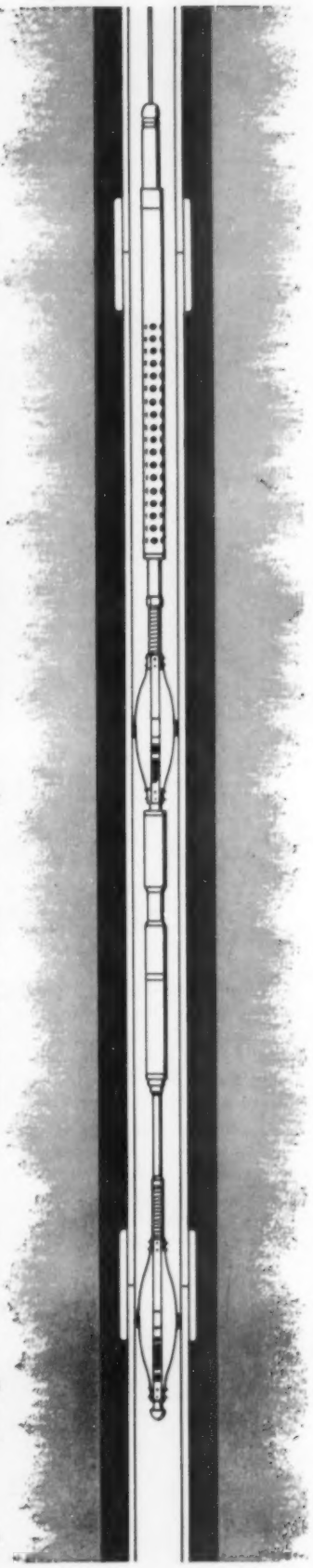
Free Point Indicator locates lowest depth where stretch and torque can be applied on the drill string.



The "String Shot" is lowered to the same depth on the same cable and detonated to loosen tool joint.



Back off recovers stuck drill pipe, drill collars, tubing or casing to permit further fishing operations.



THE DIA-LOG FREE POINT INDICATOR

This tool accurately determines the lowest depth where *both stretch and torque* can be applied to the drill string. It locates the exact point where stuck drill pipe, drill collars, tubing or casing can be freed. Movements as small as *one-thousandth of an inch* are recorded electronically on a surface indicating panel. Since reverse torque is used to back off, pipe to be recovered must be free in torque as well as stretch. *The Dia-Log Free Point Indicator gives you this correct depth in a matter of minutes!*

THE DIA-LOG STRING SHOT BACK-OFF

On the same electric conductor cable used for the Dia-Log Free Point Indicator, a "String Shot Back-Off" is run to the desired depth. Upon detonation, the "String Shot" delivers a sharp jar sufficient to start the unscrewing of the load-free joint. In thousands of successful runs, Dia-Log has recovered *millions* of feet of stuck pipe quickly and economically by employing this infallible combination. The "String Shot" also jars loose stuck tubing packers, frozen overshots, safety joints and stuck liners.

Wherever you are stuck -- Dia-Log Service is available

Dia-Log Service is available in all domestic oil fields. Wire, write or call any Dia-Log Company or Ford Alexander Corporation office for fast, dependable recovery of drill pipe.

OIL WELL ELECTRIC LINE SERVICES

Gulf Coast and Mid-Continent

THE DIA-LOG COMPANY

BOX 14103 — **HOUSTON, TEXAS**

Odessa, Texas
Hobbs, New Mexico
Farmington, New Mexico
Oklahoma City, Oklahoma
Healdton, Oklahoma
Great Bend, Kansas
New Iberia, Louisiana
Houma, Louisiana
Natchez, Mississippi
El Dorado, Arkansas
Corpus Christi, Texas
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California and Rocky Mountains

THE FORD ALEXANDER CORPORATION

BOX 800 — **WHITTIER, CALIFORNIA**

Ventura, California
Taft, California

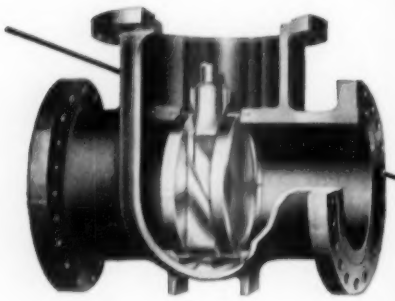
OIL MEANS LUBRICATION

Tiny wheels . . . mighty engines . . . intricate machines and processes we have come to take for granted . . . depend on oil as their lifeblood. Appropriate Schlumberger logging services determine various important drill hole characteristics, including: hole depth, size and deviation . . . the top of the cement column behind the casing . . . the depths of the casing shoe and the casing collars.

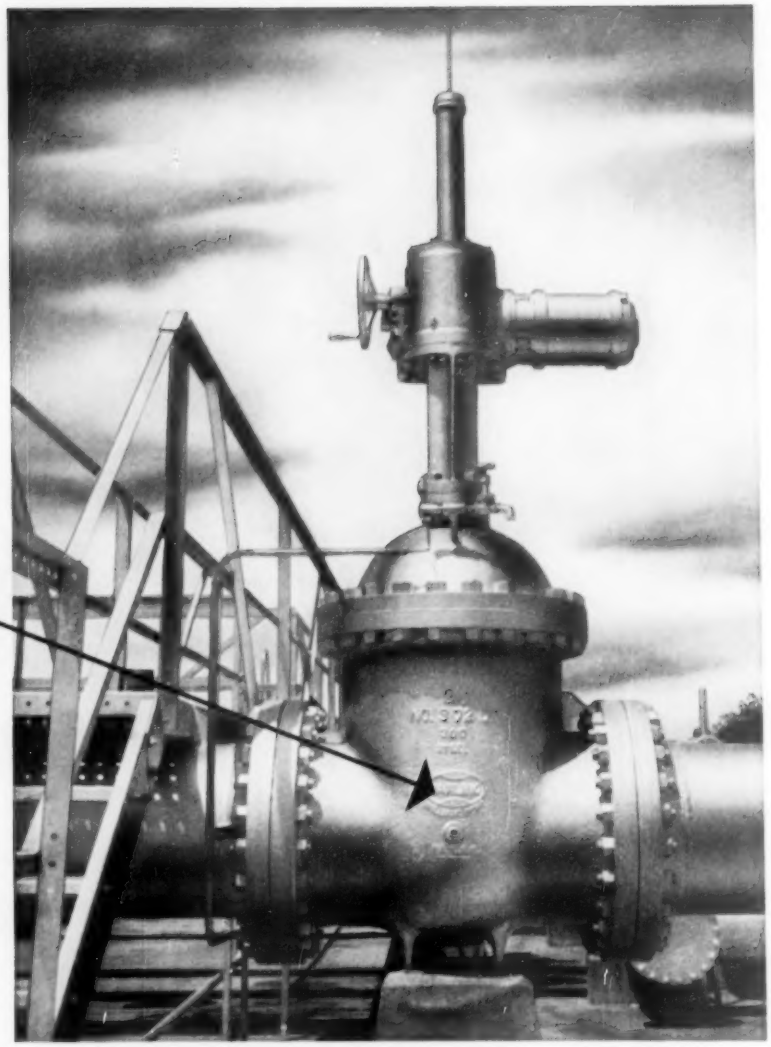
. . . and Schlumberger means Service

Schlumberger Well Surveying Corp. • Houston, Texas

LOOK INSIDE



for dollars to be saved!



Darling 24", Series 300, motor-operated gate valve, with fully revolving double disc feature, at pipe line terminal of oil pumping station.

SURE! Other things being equal, it's definitely the inside of a gate valve that really tells the story. That's why we show and stress the importance to you of Darling's *fully revolving double disc, parallel seat principle!*

Simple construction, interchangeable no-pocket discs . . . yes . . . but that's only the start. This principle assures uniform distribution of disc-and-seat wear . . . coupled with Darling's unique wedging feature it once and for all licks the problem of faulty closure due to valve body distortion . . . and greatly eases operation even under the most adverse conditions.

That's why oil and gas men everywhere have come to count on Darling gate valves for surer performance, longer life and less down time. It pays. We'll gladly give you *all* the facts on Darling valves for your particular operations. Just ask.

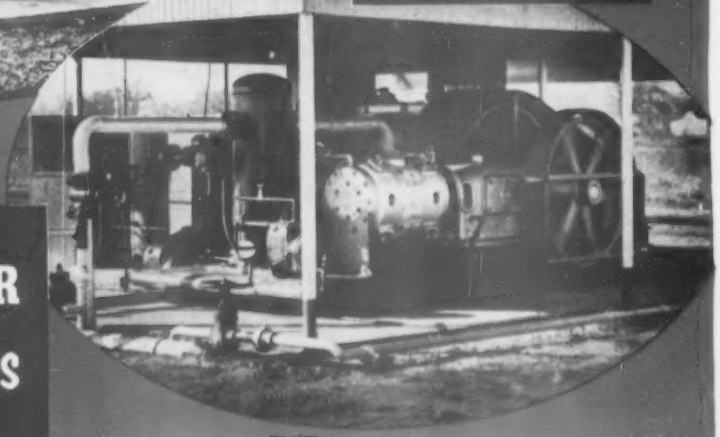
DARLING
DARLING
VALVES

DARLING VALVE & MANUFACTURING CO.
Williamsport 1, Pa.

Manufactured in Canada by Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ont.

40 LBS. INTAKE
650 LBS. DISCHARGE
1,600,000 C.F.D.

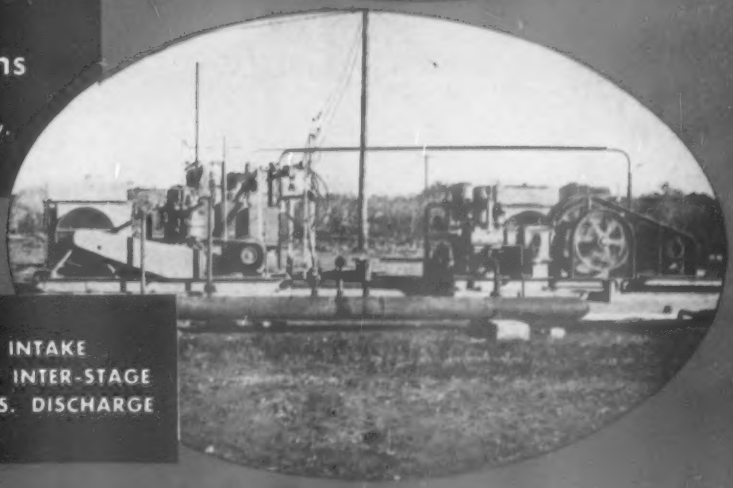
20 LBS. INTAKE
990 LBS. DISCHARGE
325,000 C.F.D.



GARDNER-DENVER
Booster Compressors

are tailored to
your field conditions

Send for Bulletin BC-1 today.



20 LBS. INTAKE
400-500 LBS. INTER-STAGE
1000-1500 LBS. DISCHARGE

SINCE 1859

GARDNER-DENVER

THE QUALITY LEADER IN COMPRESSORS, PUMPS AND ROCK DRILLS
FOR CONSTRUCTION, MINING, PETROLEUM AND GENERAL INDUSTRY

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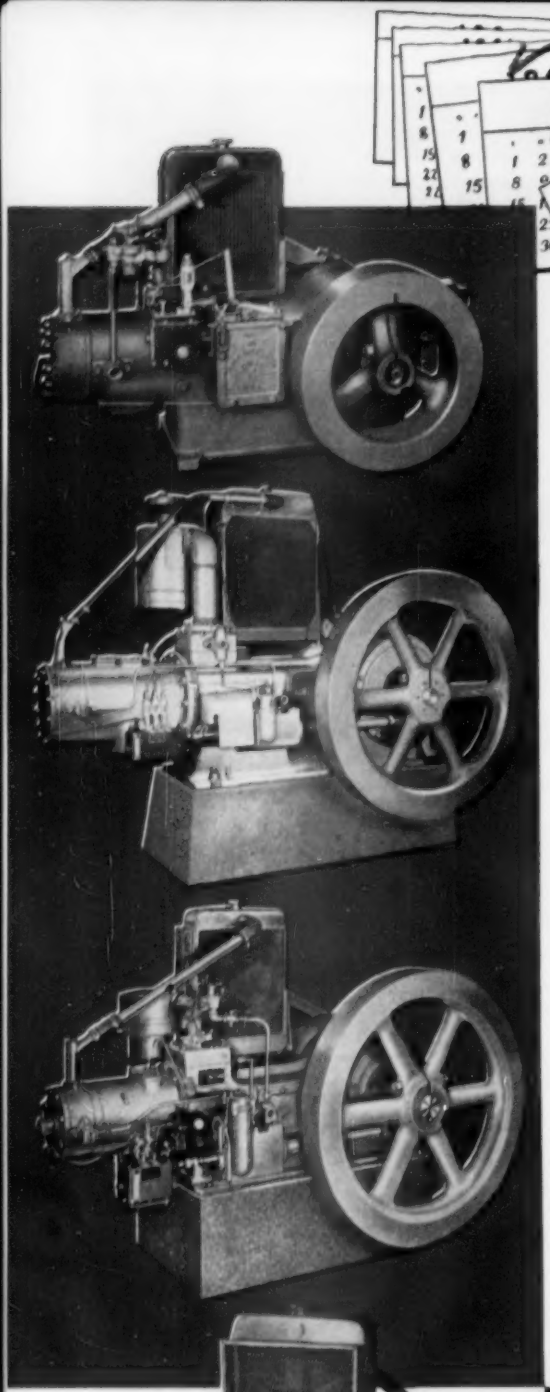
Continental Supply Co., Continental Bldg., Dallas, Texas. Export Division: 30 Rockefeller Plaza, New York, N. Y.

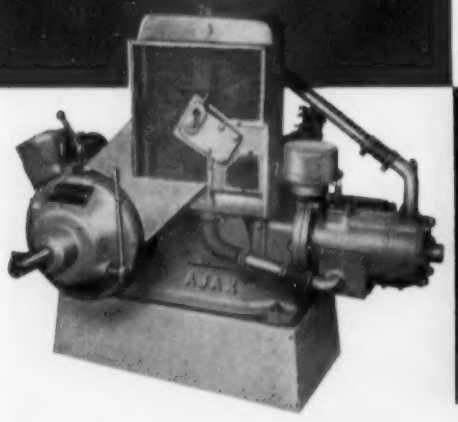


Engines that run by the year!

Your sturdy AJAX Engine—turning steadily, powerfully, smoothly under load—will maintain its pace by the month and year with little attention and even some neglect thrown in!

That's because AJAX is an *oilfield* engine all the way. It is built for seldom-visited operation in remote leases, as well as right under your thumb—glad of an annual oil change if you'll be so good, and requiring an on-location overhaul only at very long intervals.

Any model AJAX will work like that for you. And you've got the industry's only COMPLETE LINE to choose from. Write us for descriptive bulletins—and see your Supply Man for a full discussion of your needs.



AJAX

Gas and Oil Engines

Builders of GAS AND OIL ENGINES, PRESSURE PUMPS,
STEAM DRILLING ENGINES, INDUSTRIAL STEAM ENGINES

CORRY, PENNSYLVANIA

Oil Field Distributors: THE NATIONAL SUPPLY CO., PITTSBURGH, PA.
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Our Face is Red!

We never dreamed . . . that the oil industry would respond so enthusiastically to our introduction of the "Royal Scintillator." We were caught with our production down. We not only did not have enough instruments to supply the demand, we didn't even have enough catalogs. We apologize and wish to assure our customers that we are now in a position to give prompt service.

Not everyone agrees that the radiation survey technique is a proven method of oil field exploration. We agree that not enough data is available as yet, however, there is a growing body of opinion which holds that this is a valuable technique. Recent very encouraging results support this opinion.

We cannot guarantee that the Model 118 Royal Scintillator will locate oil, but we can guarantee that the Royal is the best instrument made for investigating the radiation pattern existing around oil fields. It is also the best instrument made for uranium prospecting, and its use for this purpose should not be overlooked by oil geologists.

Contact your nearest dealer or write direct for free pamphlet on "The Principles of Oil Field Detection with Scintillation Counters" and complete catalog on Geiger Counters and Scintillators.

PRECISION RADIATION INSTRUMENTS, INC.

2235 OG S. LA BREA AVE., LOS ANGELES 16, CALIFORNIA

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Company _____

Address _____ City _____ State _____

PRECISION RADIATION INSTRUMENTS, INC.

World's Largest Manufacturers of Portable Radiation Instruments

In the 3000-cu. in. displacement class...

You get *more for your*

As an engine expert, YOU be the judge

This simple checklist lets you prove it yourself

Does it have this as standard?	Le Roi L3000	Engine "A"	Engine "B"	Engine "C"	Engine "D"
1. Modern V-Type Construction	Yes	No	No	Yes	No
2. Light-weight Cam-Ground Aluminum Pistons	Yes	No	No	No	No
3. Maximum Operating Speed	1200	900	1200	1200	1000
4. Piston Speed at Maximum Continuous-Duty Speed	1283	1275	1750	1400	1500
5. Guided Valve Mechanism Full Length	Yes	No	No	No	No
6. Full-Flow Filters	Yes	No	No	No	No
7. Full-Precision Bearings	Yes	Yes	Yes	Yes	Yes
8. Overall Length — Inches	100"	110"	113"	117"	115"
9. Dual Water Circulation Pumps	Yes	No	No	No	No
10. Balanced Intake Manifolds with Single Carburetor	Yes	Yes	Yes	No	Yes
11. Crankshaft Vibration Dampener	Yes	Yes	Yes	No	No
12. Counter-balanced Crankshaft	Yes	No	No	No	No
13. Sectional Water-Cooled Manifolds	Yes	Yes	No	Yes	Yes
14. Weight per HP Based on Continuous Duty Rating	32.9	46.0	41.4	45.3	42.0

THERE'S no doubt about it — you *do get more for your money* in a Le Roi L3000.

And not only does the L3000 give you more of everything you want *as standard equipment* — it also gives you the lowest cost per hp of any 3000-cu. in. engine of this type! That's why you see this modern engine at work in so many places in the oilfields.

See what the L3000 can do for *you*. Talk it over with your supply house or Le Roi distributor.

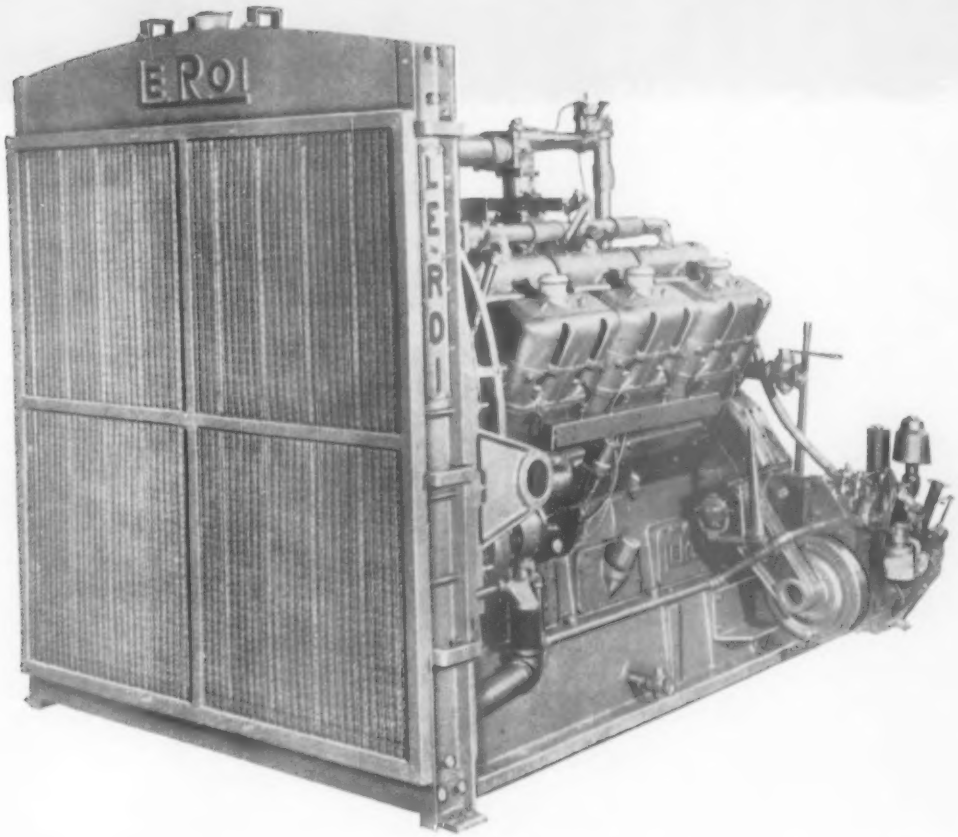
LE ROI

LE ROI COMPANY | A Subsidiary of Westinghouse Air Brake Co. MILWAUKEE 14, WISCONSIN

Plants: Milwaukee • Cleveland—Greenwich—Dunkirk, Ohio • Coldwater, Mich.
Oilfield Headquarters: Tulsa, Oklahoma

P-131

money in a LeRoi L3000



OILFIELD SALES-SERVICE NETWORK

Oklahoma
Le Roi Company Branch — Tulsa
Carson Machine & Supply Co. — Oklahoma City

East & South Texas, Gulf Coast
Southern Engine and Pump Company — Houston, Kilgore, Edinburg, Dallas, San Antonio, Corpus Christi, Texas, and Lafayette, Houma, New Orleans, Louisiana.

North & West Texas, New Mexico
General Machine & Supply Co. — Odessa, Snyder, Texas.
Nortex Engine & Equipment Co.—Wichita Falls, Texas.

Kansas
Carson Machine and Supply Co.—Great Bend

Rocky Mountain Area
Gehring Equipment Co. — Casper, Wyoming, Rangeley, Col.

Mississippi, Arkansas and Northern Louisiana
Ingersoll Corporation — Shreveport, Louisiana, El Dorado, Arkansas and Clarksdale, Jackson, Mississippi.

West Coast
Le Roi Engine Sales Co. — Long Beach, California

Appalachian Area
P. C. McKenzie Co., Pittsburgh, Bradford.

Canada
Lucey Export Ltd. — Calgary, Edmonton, Alberta.

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PYRENE and C-O-TWO, world-renowned manufacturers of approved fire protection equipment, are now unified under the same management to give you the finest and most complete line on the market today . . .

- **built-in fire detecting systems that quickly respond to smoke, heat or flame . . .**
- **all types of portable fire extinguishers and built-in fire extinguishing systems that kill fire fast . . .**
- **plus an expert fire protection engineering service that gives you unbiased advice on what is best for your particular fire hazards.**

Don't take unnecessary chances . . . the combined fire protection experience of PYRENE and C-O-TWO over the years is at your disposal without obligation. Get complete facts today!

Pyrene

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C-O-TWO

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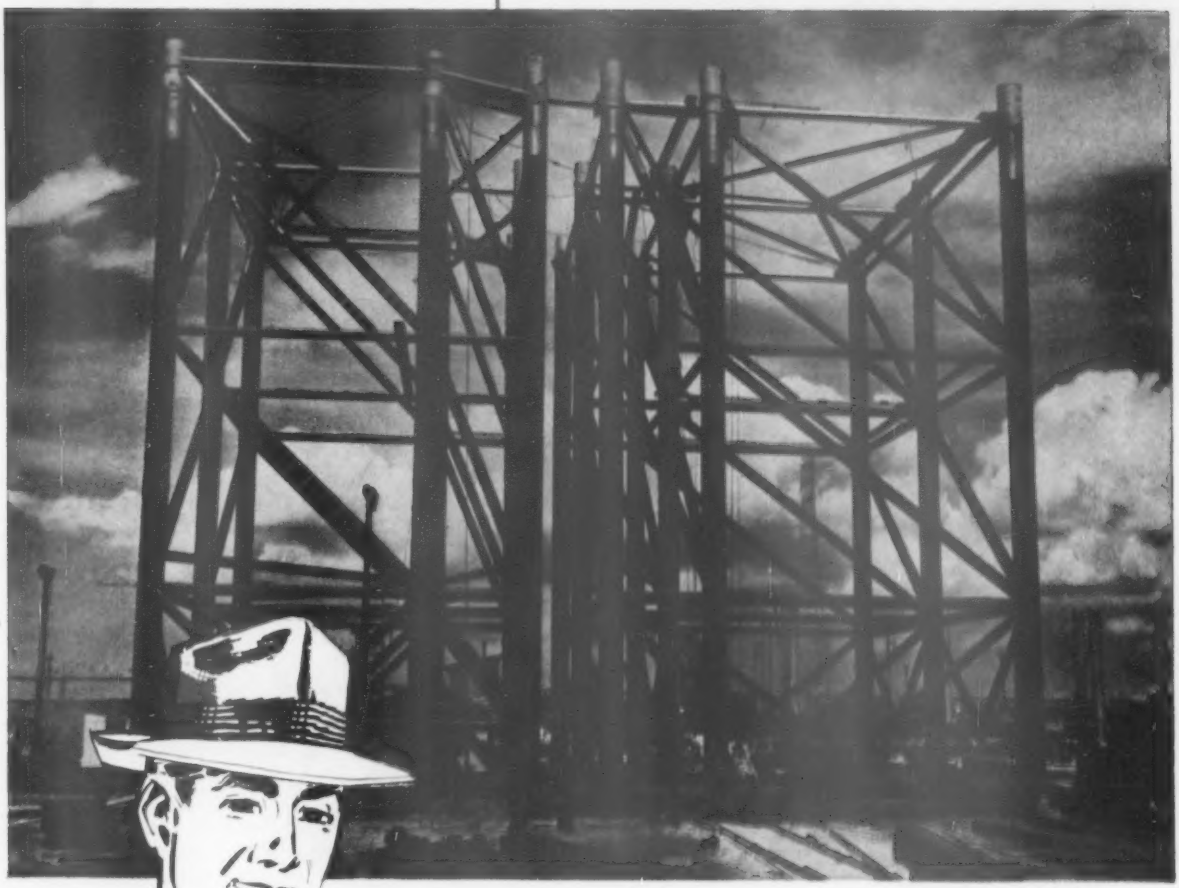
no job is too BIG for AVONDALE



60' Section of CALCO Pipe Jacket built by Avondale. In the background to the right, fabrication of superstructure.

The business of offshore drilling is a BIG business, requiring BIG equipment. The Petroleum Industry needs Drill Barges, Derrick Barges, Pile Driver Barges, Pipe Jacket and Platform Structures—all built to the highest standards of quality and performance. Avondale knows how to give the Oil Industry what it wants and needs in the way of construction, repair and fabrication. Their fame is well known . . . their Integrity and "know-how" unchallenged.

CONSULT AVONDALE ON YOUR NEXT JOB.

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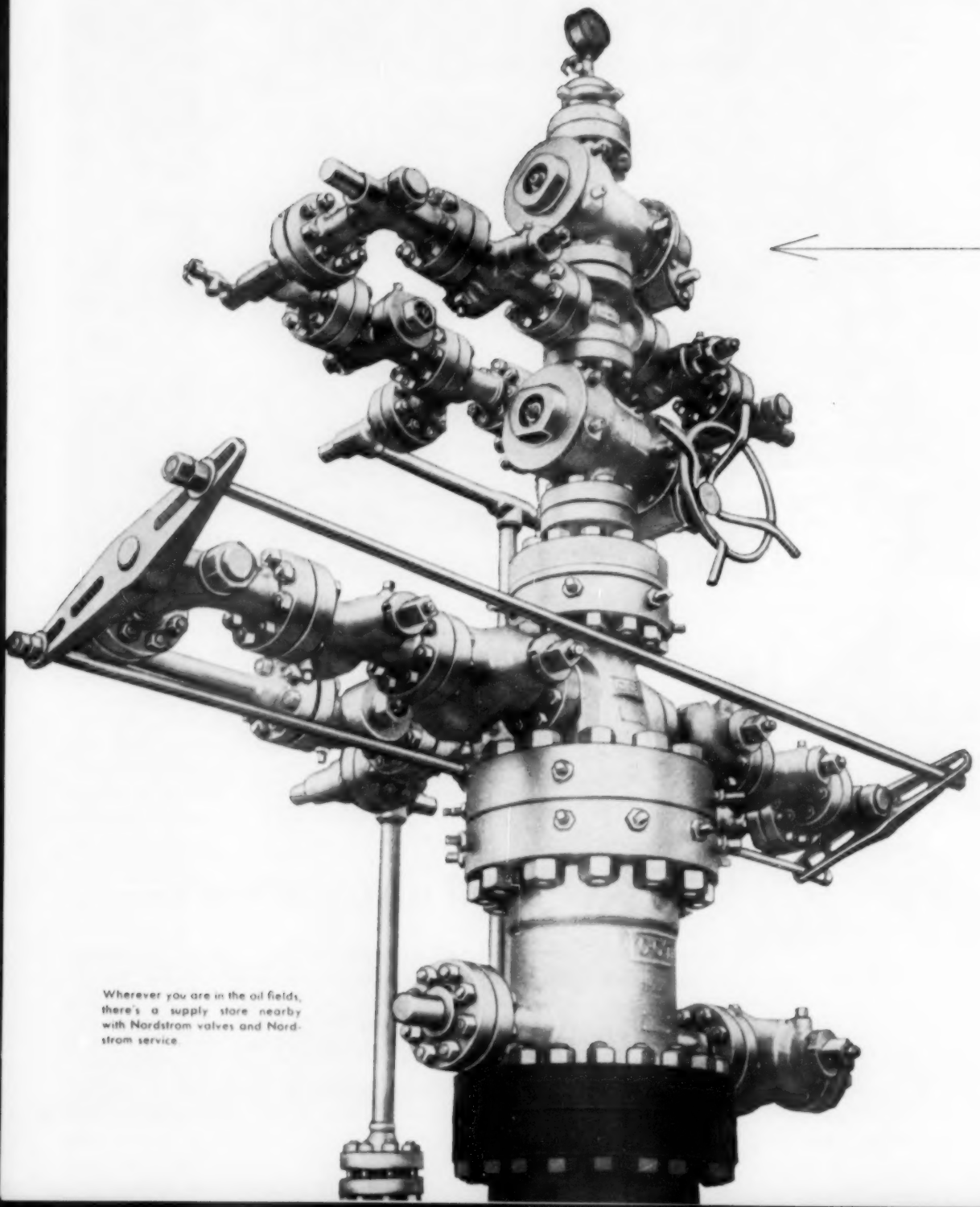
P. O. BOX 1030 • PHONE UNiversity 4561 • NEW ORLEANS 8, U. S. A.

Any Way You Look At It

ROCKWELL-Nordstrom **is the**



Wherever you are in the oil fields, there's a supply store nearby with Nordstrom valves and Nordstrom service.

Best Christmas Tree Valve

And here are the sound reasons why

EASY TO OPERATE — *Any time!*

Even after a Rockwell-Nordstrom valve has operated in one position for long periods under adverse field conditions, it can be opened or closed with minimum effort. The plug and body bearing surfaces are lubricated, and lubricant also hydraulically lifts the plug away from the body to permit easy operation.

SURE SHUT-OFF — *Every time!*

Rockwell-Nordstrom lubricant has another purpose: it acts as a plastic seal around the valve ports, constantly renewed from the internal lubricant reservoir.

LONG LIFE — — *Always!*

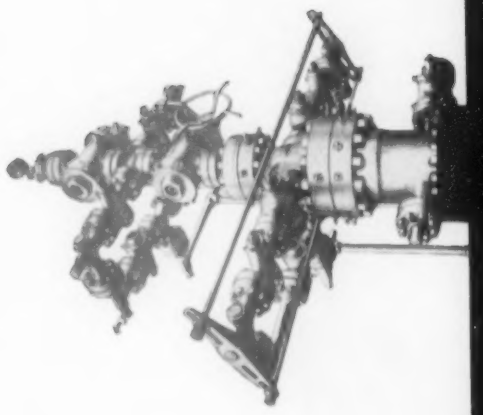
Since lubricant prevents metal-to-metal contact, plug and body seat life is far, far longer. Lubricant is the natural foe of the abrasion that causes wear.

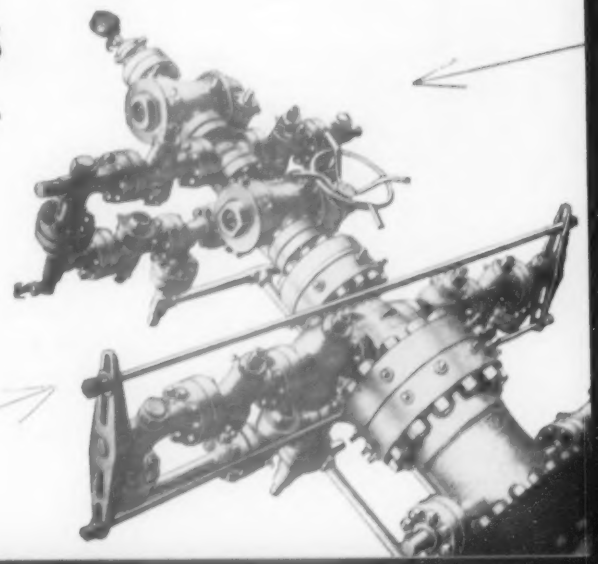
It's wise to specify Nordstrom valves for wellhead service. Rockwell-Nordstroms are made in all required sizes and pressure classes, standard or Hypreseal patterns, carbon or stainless steels, and with Merchrome hard-faced body and plug for the higher pressures. Rockwell Manufacturing Company, Pittsburgh 8, Pa. *Canadian Licensee: Peacock Brothers Limited*

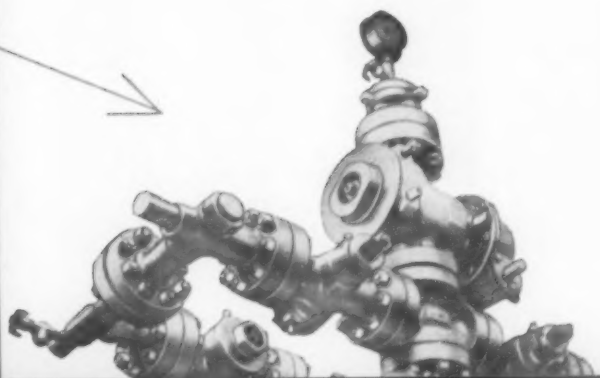
ROCKWELL

Nordstrom **VALVES**

Lubricant-Sealed for Positive Shut-Off







World's Finest Oil Field Power
WAUKESHA

ENGINES and POWER UNITS 10 hp. to 600 hp.

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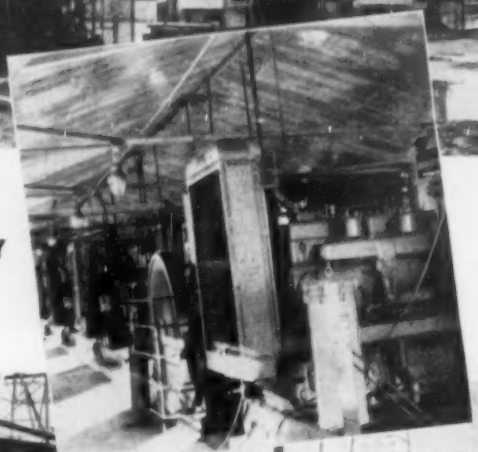
BULLETIN 1079

It gives complete line of Waukesha Oil Field Engines for gas, gasoline, normal Diesel, or turbocharged Diesel operation—to 600 hp.



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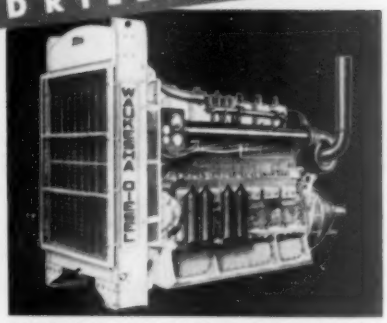
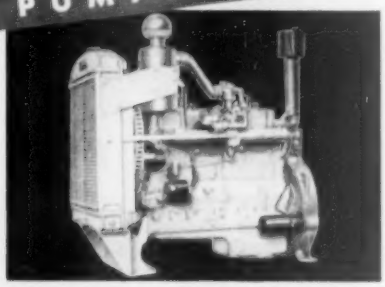
DRILLING



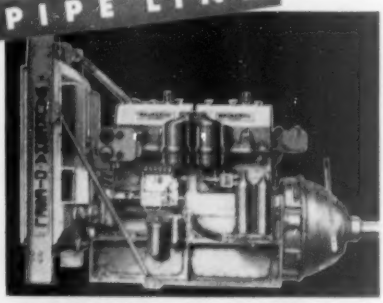
LRDBSU Turbocharged Diesel Unit — six cylinders, 8½-in. bore x 8½-in. stroke, 2894 cu. in. displacement, 526 hp at 1200 rpm, maximum.

PUMPING



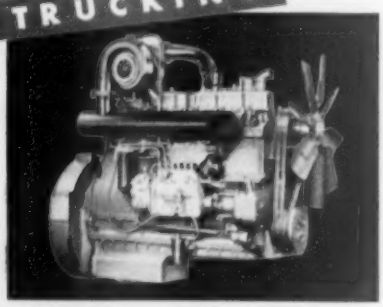
145-GZBU Gas Power Unit — six cylinders, 5⅜-in. bore x 6-in. stroke, 817 cu. in. displacement, 176 hp at 2000 rpm on natural gas.

PIPE LINE



NKDBU Normal Diesel Power Unit — six cylinders, 7-in. bore x 8¼-in. stroke, 1905 cu. in. displacement, 274 hp at 1200 rpm, maximum.

TRUCKING



148-DKBS Turbocharged Truck Diesel — six cylinders, 5¼-in. bore x 6-in. stroke, 779 cu. in. displacement, 280 hp at 2100 rpm.

PROCESS EQUIPMENT NEWS

PUBLISHED BY FABRICATED PRODUCTS DIVISION, THE M. W. KELLOGG COMPANY NOVEMBER 1954

Interchangeable Bundles for Three Condenser Units

Three condensers recently completed in the Kellogg shops for a major refiner represent an optimum interchangeability of bundles—a feature every refiner wants but one that is often difficult to achieve in a unit without over-engineering it.

The three condenser units, designed to handle C-4 cuts, comprise a total of 14 shells. Following normal design practices, initial Kellogg engineering proposals included three sizes of shells. However, further study by Kellogg engineers proved, in this instance, that it would be most economical in the long run to design the entire group of 14 shells for interchangeable bundles. Both proposals were submitted, the customer agreeing that the interchangeable bundle plan best served their purposes.

Each of the 14 sections are of floating tube sheet construction with 2040 square feet of ¾-inch admiralty tubes, naval brass tube sheets, and steel baffles. Inside diameter of each shell is 33 inches.

Interchangeable bundles for this many sections will offer several important advantages to the refiner. They will, for example, cut down considerably on refinery maintenance stock, since only one spare bundle need be kept in stock to service any one of the 14 sections. Shorter down-time for repairs are also expected to result from the fact that the spare bundle can be substituted easily in an emergency without shutting the unit down for lengthy repairs or rebuilding.

For further information, details of methods, etc. contact

FABRICATED PRODUCTS DIVISION

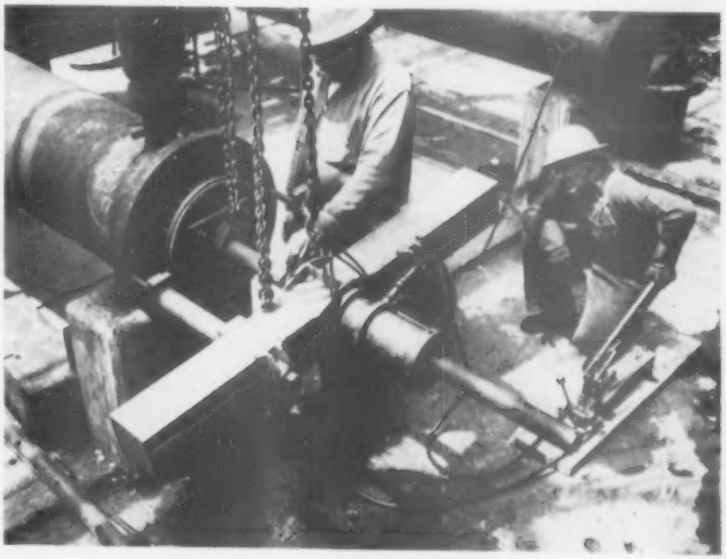
THE M. W. KELLOGG COMPANY

225 Broadway, New York 7, N. Y.

In Canada
The Canadian Kellogg Company, Limited

In Europe
Kellogg International Corporation

KELLOGG PULLMAN



Portable Bundle Puller Saves Time Eliminates Costly Rigging

Shown here in use at a major Eastern refinery is Kellogg's special device, known as the Hydro-ejector, for removing and inserting heat exchanger bundles.

The device, portable and easily operated by two men, reduces down-time and eliminates the need for "jerry-built" rigging often required to pull even the smallest tube bundles. From the standpoint of time, experience has shown that it takes less than 25 minutes for the device to push a tube bundle out eight feet.

And even the largest bundles will not stick when pushed by the force of 12,000 pounds that may be exerted by the Hydro-ejector. The device is attached directly to the bonnet-end shell flange of the exchanger. It does not pull a bundle; it pushes it.

The Hydro-ejector is safer to use—particularly in the case of overhead exchangers—because workmen do not have to clamber out on the bundle after it is partly pulled to attach hoists. Ropes for lowering the bundle are attached as it is ejected and ride along with the unit from a trolley on the hoisting beam.

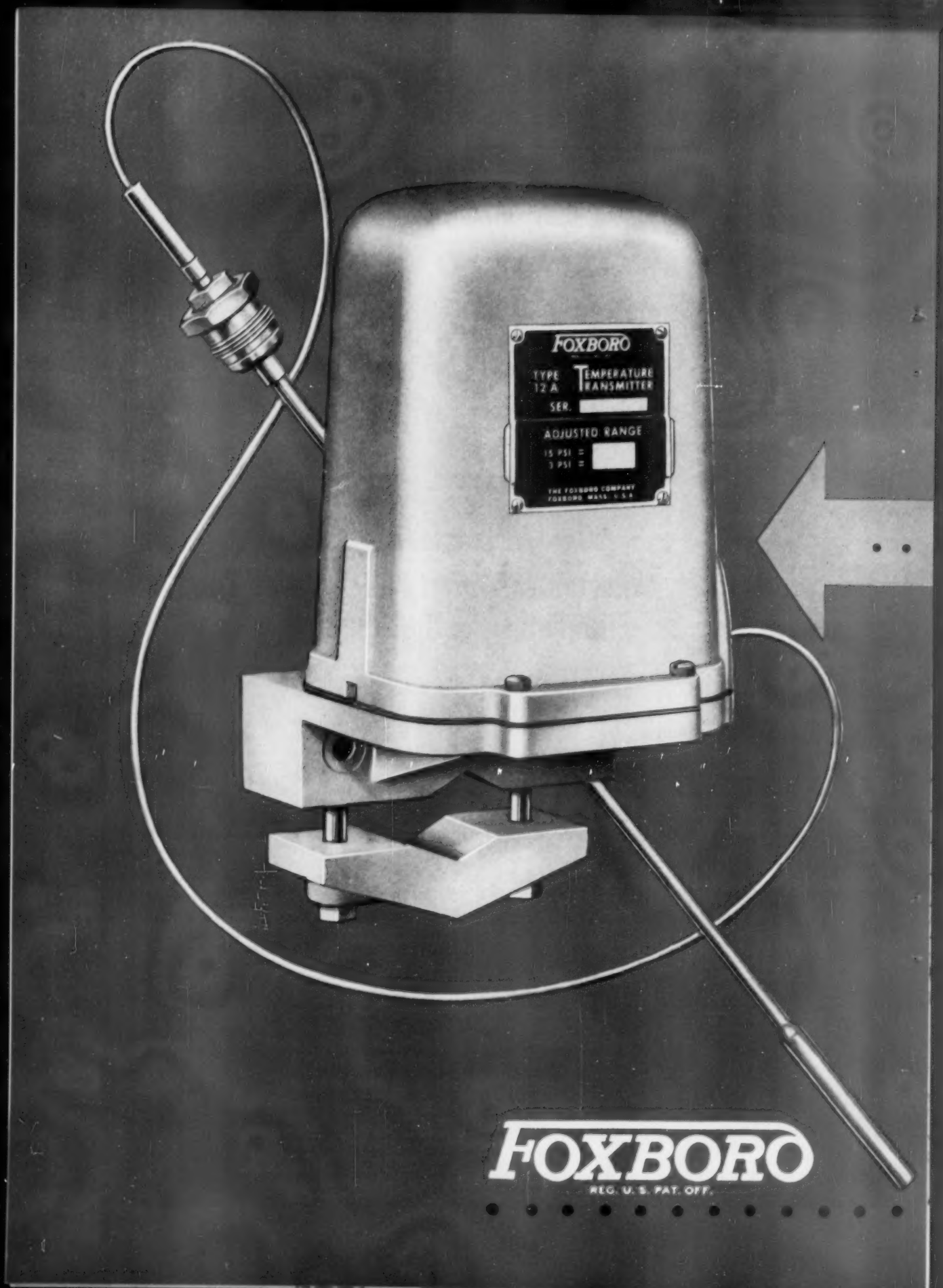
The Hydro-ejector will fit any size exchanger. Although now available for use in existing refineries, the unit was originally designed for customary types of exchangers in new processing plants as a means of reducing investment for supporting steel work. In cases where more than one Hydro-ejector is used, all parts including the jack and pumping unit are interchangeable. The only auxiliary equipment are two hoists, suspended at the channel end of the exchanger, to handle the tube bundle as it is ejected or replaced.

In operation, two men may work it with ease. One is required to pump the jack while the other keeps an eye on the bundle to ensure alignment.

Each unit consists of a hydraulic center-hole jack, supported by a fabricated steel base which is bolted directly to the exchanger. It is self-contained and portable, the heaviest piece of equipment being less than 75 pounds.

Send for New Booklet On Kellogg Exchangers

A new booklet which describes in detail the types of tubular heat transfer equipment available from Kellogg has just been completed. It not only shows examples of a variety of heat exchangers, coolers, condensers, reboilers and other process equipment, but also covers in some detail the expanded facilities available at Kellogg since the shops were modified for production-line manufacture of heat transfer units.


FOXBORO
TYPE 12 A
TEMPERATURE TRANSMITTER
SER.
ADJUSTED RANGE
15 PSI =
3 PSI =
THE FOXBORO COMPANY
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FOXBORO
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Rugged, Versatile Temperature Transmitter Improves Remote Control

. the Foxboro M/12A (pneumatic)

There is no easier, simpler way to measure remote temperatures, *fast*, over so wide a range, with such high sustained accuracy, and at so low a cost!

Between the limits of —100°F. and +1000°F., with operational spans of 50°, 100°, 200°, and 400°F, this rugged, highly responsive instrument performs outstandingly under the most severe conditions. It is fully compensated for ambient temperatures and pressure, and is insensitive to mechanical vibration.

Derivative action can be furnished for optimum performance when substantial thermal or transmission lags exist.

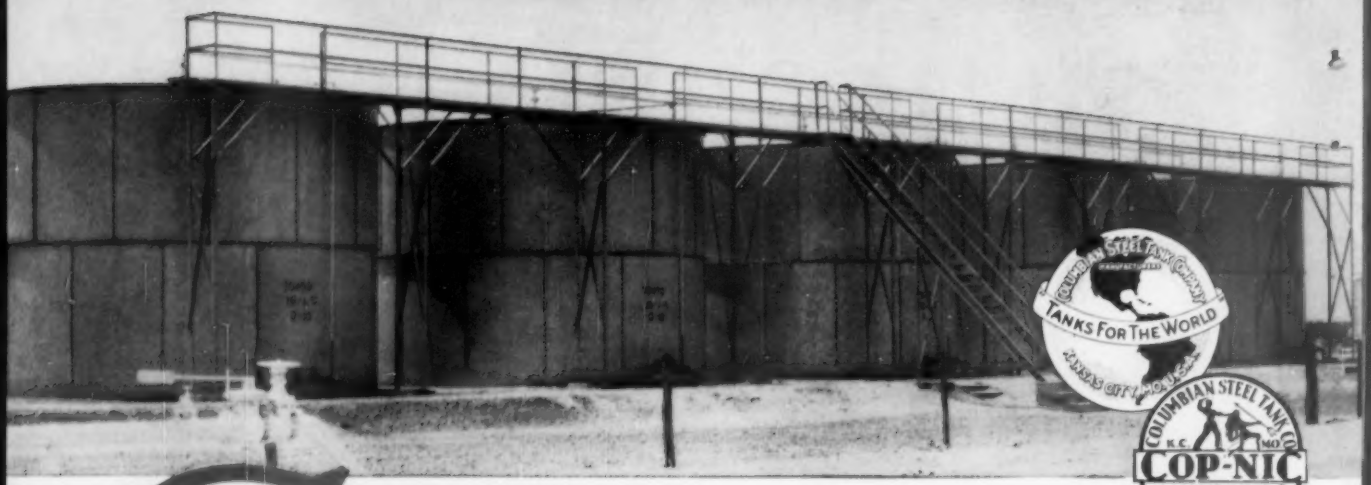
With its weatherproof housing and integral mounting bracket, it can be installed in any hazardous, corrosive, or outdoor location. Transmission lines are ¼" O.D. tubing — no troublesome conduit, no costly capillary to run.

Write for Bulletin 13-17. It explains fully why the Foxboro M/12A Temperature Transmitter gives better performance with lower installation and maintenance cost. **The Foxboro Company, 6011 Neponset Ave., Foxboro, Mass., U.S.A.**

FACTORIES IN THE UNITED STATES, CANADA AND ENGLAND

• • Pneumatic Temperature Transmission

FIRST with API TANKS of Every Size



COLUMBIAN BOLTED STEEL TANKS

Years ago when the American Petroleum Institute decided on standard specifications for API tanks, COLUMBIAN immediately developed API tanks in every size. Today, COLUMBIAN continues this leadership in storage tank design and fabrication and remains FIRST in the minds of oil producers all over the world. Because exclusive construction features, easy assembly and long life service mean extra value in every COLUMBIAN tank.

COLUMBIAN ALL-METAL BUILDINGS are proved money-savers as warehouses, engine houses, garages, equipment and storage houses. Rigid, strong, fire-safe, low upkeep. Write for complete facts.

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Houston, Texas

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P. O. Box 42
Beeville, Texas

WYOMING
O'Neill Tank Company
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Casper, Wyoming

COLUMBIAN STEEL TANK CO., P. O. Box 4048-J, Kansas City, Mo.

MEMO

POWELL has a complete line of refinery valves!

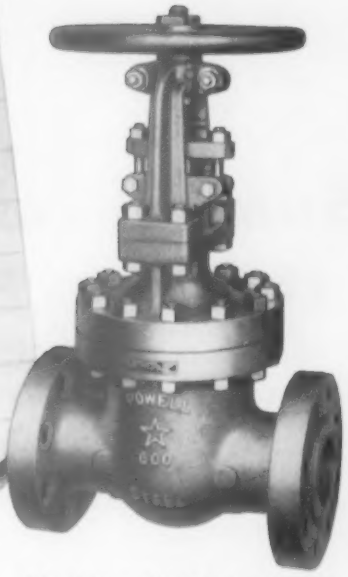


FIG. 6003 — 600-POUND CAST STEEL GATE VALVE. Flanged ends, outside screw, rising stem. Available in sizes 1" to 24", inclusive.

...AND FOR ALL SERVICES! Shown here are just a few of Powell Valves from the complete line of refinery valves in stock. But no matter which type you choose, you can be certain of *dependable* flow control.

Investigate the complete line of Powell refinery valves for all services—valves that have a proven record of long life and dependable service.

Consult your Powell Valve distributor. If none is near you, we'll be pleased to tell you about our complete line, and help solve any flow control problem you may have. Write The William Powell Company, Cincinnati 22, Ohio.

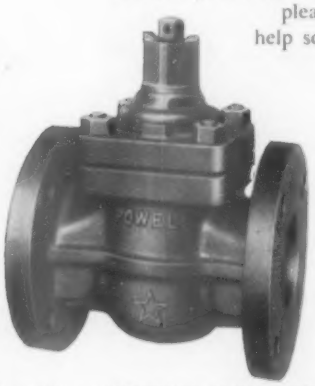


FIG. 2201—LUBRICATED PLUG VALVE. Flanged ends. Available with screwed or bolted glands. Semi-Steel valves available for 175 and 200 pounds W.O.G. Carbon Steel Valves available for 150 and 300 pounds W.P. Sizes 1" to 12", inclusive. Powell Lubricated Plug Valves are also made in Bronze, Ni-resist, Monel and other metals. Sizes above 6" can be furnished for gear operation.

FIG. 3061—300-POUND CAST STEEL SWING CHECK VALVE. Bolted flanged cap. Heavy rugged construction. Available in sizes 1" to 12", inclusive.

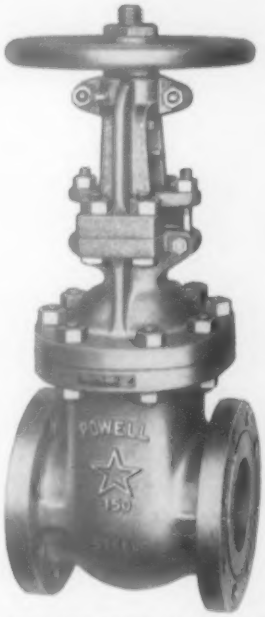


FIG. 1503—150-POUND CAST STEEL GATE VALVE. Flanged ends, bolted flanged bonnet with outside screw rising stem and yoke. Solid wedge. Available in sizes 1" to 24", inclusive.

CONTROLS FOR THE LIFE LINES OF INDUSTRY

Powell Valves 108th year

Sun Oil Company Puts New B&W "CO" BOILER On Stream at Toledo

SUNOCO

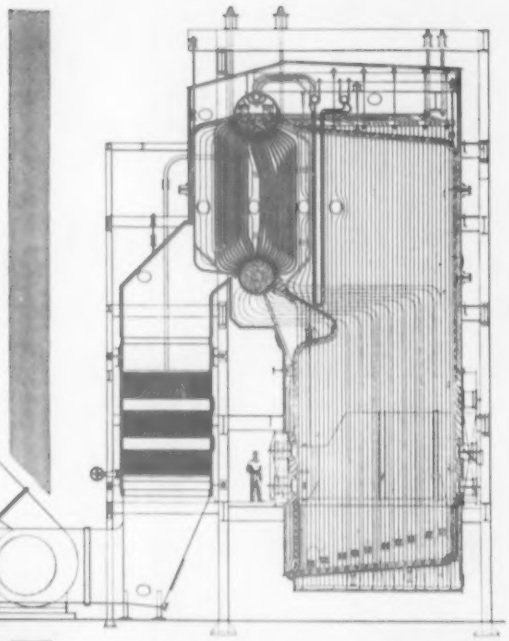
Waste heat at Sun Oil Company's Toledo, Ohio, refinery is being put to work to generate some 50,000 pounds of steam per hour. Add this to the 140,000 lb per hour generated from conventional fuels, and the total output of this B&W Carbon Monoxide Boiler is 190,000 lb per hour; steam to run compressors and other "cat cracker" auxiliaries efficiently.

When the catalytic cracking unit is on stream, the CO Boiler is fired with the exhaust gas from the catalyst regenerator in combination with fuel oil or refinery gas. The sensible heat and combustible carbon monoxide and any unburned hydrocarbons in the catalytic gases, exhausting from the regenerator of the cracking unit at a rate of 150,000 lb per hour, are used to produce 50,000 lb of steam per hr in the CO Boiler, instead of being expelled as waste gas. When the catalytic cracking unit is shut down, the CO Boiler, oil-fired, is available to operate as a conventional boiler, supplying steam whenever it's required.

Sun Oil has spent well over $1,000,000 in order to improve the surrounding atmosphere as much as possible by eliminating smoke and recovering valuable heat otherwise lost. This fuel saving is expected to amortize the investment in approximately four years.

This major stride in "putting waste heat to work" is the result of close cooperation between Sun Oil Company, Gilbert Associates, and The Babcock & Wilcox Company. Confidence in this project has resulted in the ordering, by Sun Oil Company, of two additional boilers from B&W for burning waste catalytic gases.

There are now three CO Boilers in operation—all Babcock & Wilcox. Let us discuss with you the working advantages of the CO Boilers and give you additional details. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

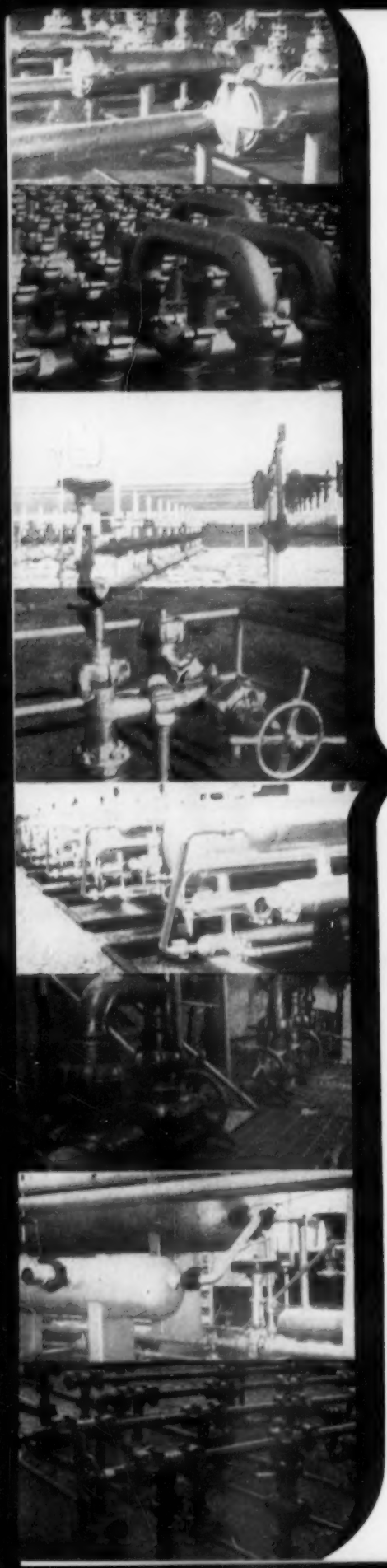


Sectional side elevation of CO Boiler.

General view of Houdriflow Catalytic Cracking Unit at Toledo. B&W CO Boiler is in foreground.

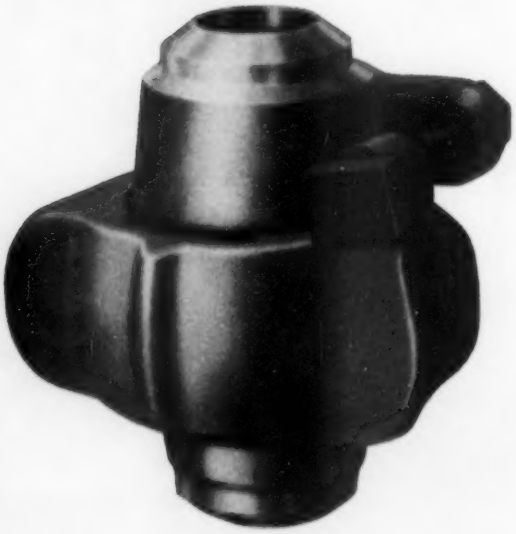
BABCOCK & WILCOX

BOILER DIVISION



THERE IS ONLY ONE

UNIBOLT



Distinctive features: **Lighter but stronger** — its unique design results in minimum bulk and weight yet places more metal in shear to provide greater strength. **One bolt** — simplifies assembly and disassembly and serves only to draw tapered interlocking shelves together, carrying none of the load of the coupling itself. **Adaptability** — its design readily permits adapting it to numerous fittings, as well as pipe couplings. **Interchangeability** — any part for a given size and type coupling or fitting is interchangeable, permitting minimum warehouse stocks of UNIBOLT products and replacement parts. **Broad field of application** — ALL UNIBOLT products utilize the same basic mechanical design, only the seal rings, or gaskets, differ with the class of service.

THORNHILL CRAVER CO.

P. O. BOX 1184 HOUSTON, TEXAS

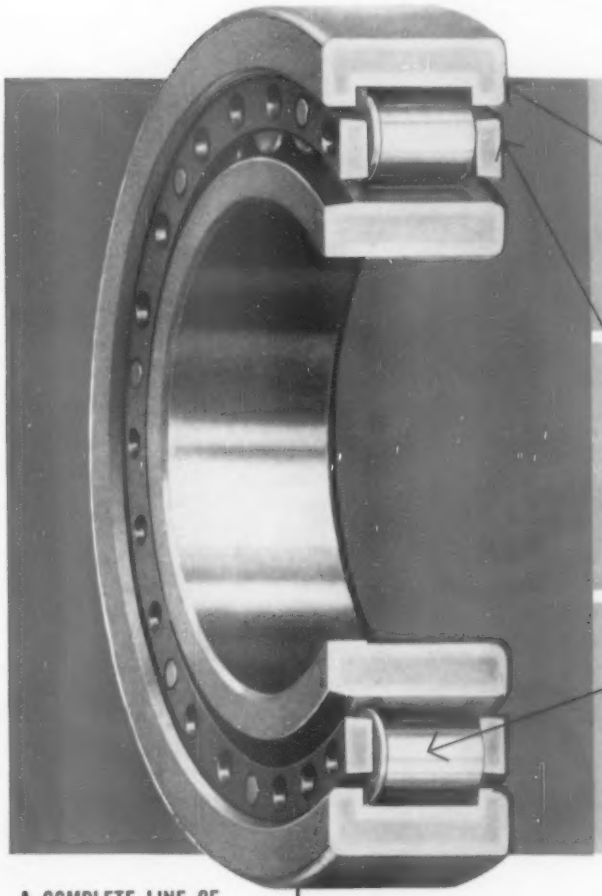
Here's why BOWER straight roller bearings can carry maximum loads—with less maintenance!

The important design features of Bower straight roller bearings shown on this page are just a few of the reasons why these bearings will operate efficiently and economically in your product. Consider these facts, too. Bower straight roller bearings incorporate highest quality materials and workmanship. They have proved themselves capable of standing up day in and day out under maximum loads—with little or no maintenance.

In fact, this is the reason why Bower straight roller bearings are used extensively by leading manufacturers in such fields as automotive, earthmoving, farm equipment and machine tool.

Let a Bower engineer give you full details of the complete Bower line. Call him in while your product is still in the blueprint stage.

BOWER ROLLER BEARING COMPANY • DETROIT 14, MICHIGAN



● *TWO-LIP RACE INCREASES RIGIDITY.* These two shoulders, made parallel, are integral with the outer race. This provides a more rigid, durable construction. Rollers are kept in proper alignment at all times.

● *COMPOSITE STEEL CAGE DOES NOT CONTACT ROLLERS DURING NORMAL OPERATION,* thereby allowing free movement of the rollers between the races. Projections on the inner faces of the rings engage indentations on the roller ends preventing the rollers from dropping out of position when the separable race is removed.

● *PRECISION-BUILT ROLLERS AND RACES ARE MADE TO SUPPORT MAXIMUM RADIAL LOADS.* Only the highest grade steel-alloy is used, and rollers and races are precision ground to give quieter, smoother operation. Running clearance is built in at the time of manufacture.

A COMPLETE LINE OF TAPERED, STRAIGHT AND JOURNAL ROLLER BEARINGS FOR EVERY FIELD OF TRANSPORTATION AND INDUSTRY

BOWER

ROLLER BEARINGS

THERE'S NO MAGIC ABOUT IT

DON'T BE SURPRISED, the next time you're traveling through Lebanon, if you see a sign at a refinery which reads, "Built by Procon." You may run across one on a chemical plant in England. You'll find them in Australia, Canada, Germany, Belgium, the Canary Islands, and in 18 of the 48 United States.

Yes, Procon gets around. And Procon's reputation gets around, too . . . a reputation for dependability . . . worthwhile economies . . . on-time completion . . . and long-time satisfaction in the construction of processing facilities for chemicals, petrochemicals, and petroleum products.

No magic . . . just sound, common sense . . . practical engineering ability . . . field-trained personnel . . . and experience which encompasses the world.

When you're ready to discuss your process construction plans, we'd welcome an opportunity to tell you more about Procon.

PROCON *Incorporated*

PROCESS CONSTRUCTION

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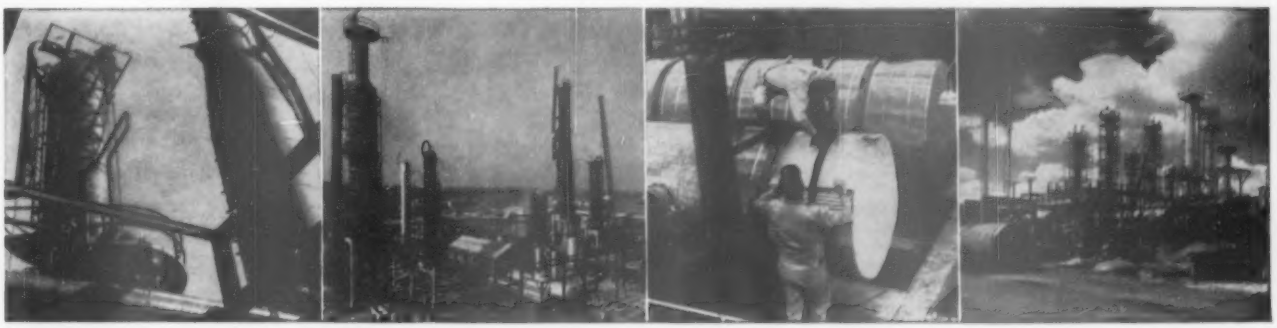

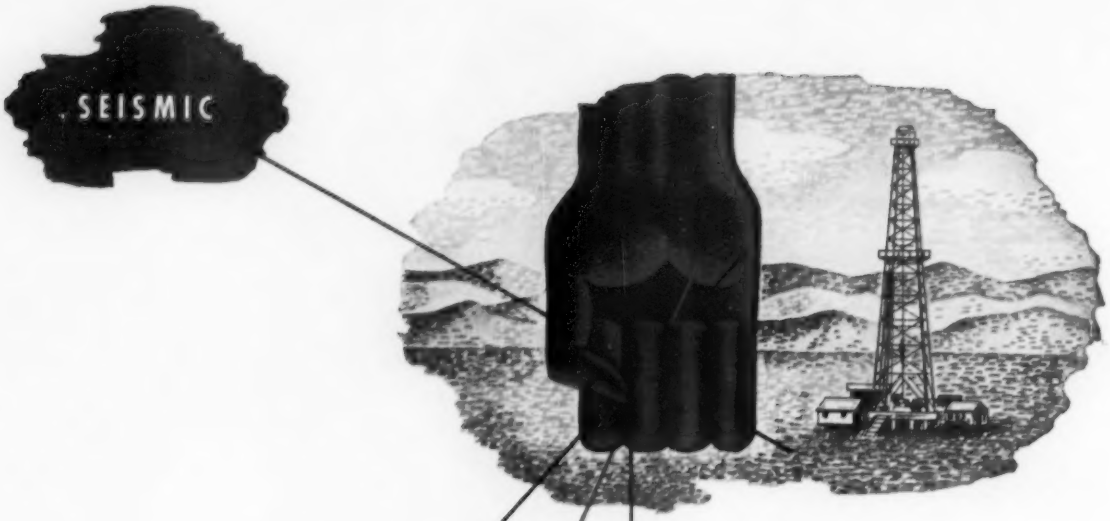

MAGNETIC

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29 YEARS...

of world-wide
Geophysical Experience
go into
every job
we undertake

Petty

GEOPHYSICAL ENGINEERING COMPANY

SAN ANTONIO, TEXAS

SEISMIC • GRAVITY • MAGNETIC SURVEYS

Butyrate pipe cuts installation time

Tenite Butyrate's light weight and easy joining by solvent welding can cut labor installation costs by more than 60%.

Butyrate pipe cuts corrosion failures

Tenite Butyrate resists corrosion by sour crudes, brine and electrolytic soils. This Tenite section from a salt water disposal line is still in good condition after 2 years' service. On the same line, metal pipe used to fail completely in 6 months.

Butyrate pipe cuts paraffin clogging

How much time do you lose in cleaning out paraffin-clogged metal lines? The clean, smooth inner wall of a Tenite pipe offers no toe-holds for paraffin.

Could Tenite Butyrate cut costs for you?

SAVINGS BEGIN the minute you order Tenite Butyrate pipe. Its light weight saves freight, handling and distribution costs. Simple solvent welding with slip-sleeve couplings makes it fast to install. You have no expensive corrosion failure replacements, no periodic cleaning out of accumulated paraffin.

This lightweight pipe is only 1/12th the weight of cement-lined metal pipe. It has good impact resistance and performs well over a wide temperature range.

The petroleum industry has long sought a lightweight, corrosion-resisting pipe that would be strong enough to take the abuse of oil field use. Tenite Butyrate gives you this combination. Years of successful service in all types of fields prove its complete suitability for crude, corrosive water and brine lines. Mail the coupon for more information plus a list of Tenite pipe suppliers. EASTMAN CHEMICAL PRODUCTS, INC., Kingsport, Tennessee, subsidiary of Eastman Kodak Company.

TENITE
BUTYRATE
an Eastman plastic

EASTMAN CHEMICAL PRODUCTS, INC.
KINGSPORT, TENNESSEE

Please send me information on TENITE BUTYRATE PIPE and a list of companies manufacturing Tenite pipe and fittings.

NAME .....
POSITION .....
COMPANY .....
STREET .....
CITY ..... STATE .....
OG-1154

CROUSE-HINDS EV Series

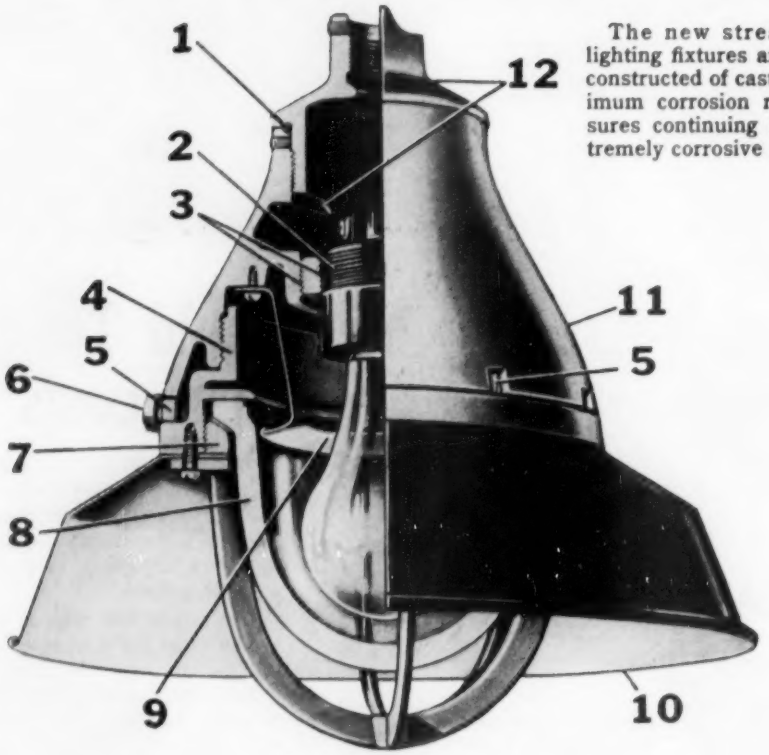
have been redesigned to give you:

EASIEST installation

EASIEST maintenance

HIGHEST efficiency

This adds up to big savings on every installation!

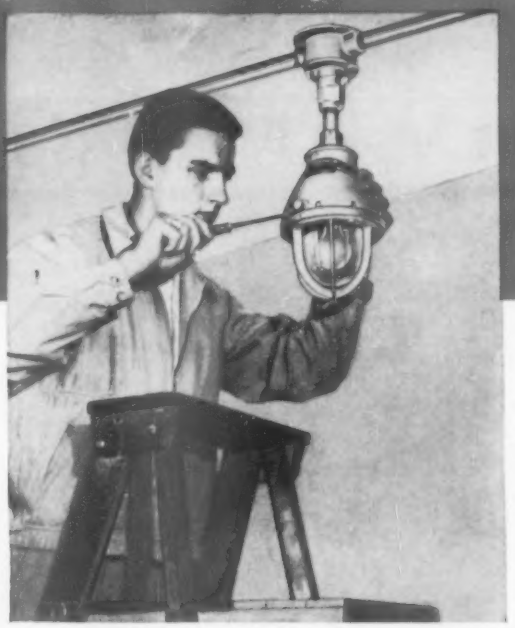


The new streamlined EV lighting fixtures are completely constructed of cast metal. Maximum corrosion resistance insures continuing safety in extremely corrosive locations.

1. Rubber O-ring gasket . . . seals joint against dirt or liquids.
2. New improved shock-absorbing receptacle has "universal" action . . . absorbs shock from *any* direction.
3. Threaded joints are flame tight . . . no sealing compound or external seals are required.
4. Lightweight one-piece assembly of globe, holder, guard and reflector is threaded high up inside of hood . . . no liquid or dirt can enter.
5. Notches in hood and globe holder . . . easy to loosen with a screwdriver.
6. Large knurled thumb screw . . . sets between notches for positive locking.
7. Globe retaining ring and cushioning gasket.
8. Heat and impact resisting globe. The accurately ground flange, essential for safety, is protected in a factory assembled joint . . . never exposed to damage.
9. Auxiliary reflector . . . etched Alzak aluminum . . . eliminates "trapped" light.
10. Porcelain enameled steel reflector.
11. Cast aluminum hood.
12. Cast aluminum body . . . has two openings for easier wiring from either side.

CONDULETS · AIRPORT LIGHTING

Explosion-Proof LIGHTING FIXTURES



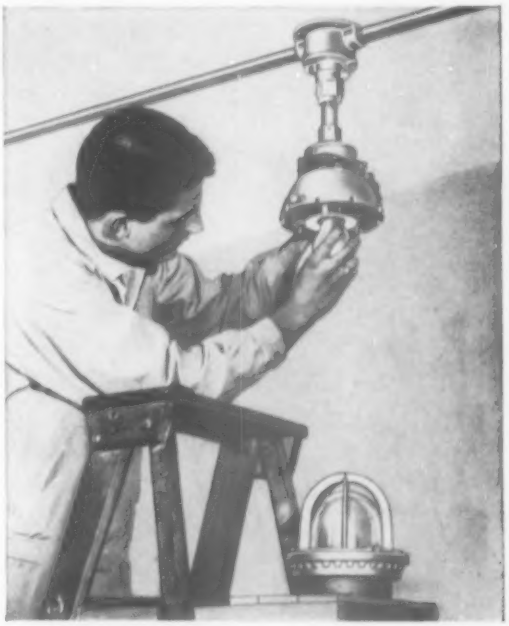
Easiest Relamping—3 Simple Steps

1. Single unit globe-holder assembly threaded into fixture hood is quickly removable for relamping. Slots are provided for prying with a screw-driver when necessary in corrosive atmospheres or other severe conditions. A large knurled thumb screw is easily loosened to unlock the globe and holder.

2. Globe and holder complete with guard (and reflector if used) is removed as an assembly. Only one lightweight piece to handle—globe retained in holder with flame-tight joint fully protected. Explosion-proof integrity assured. The 200/300-watt globe-holder assembly weighs but 8 lbs.

The new design of EV Explosion-Proof Lighting Fixtures is based on exhaustive studies and tests in Crouse-Hinds laboratories. The goal was to produce a fixture that would be easier to install and easier to relamp than any other explosion-proof fixture. Crouse-Hinds designers not only achieved this result but also created a fixture having the highest possible lighting efficiency.

You get 3-way savings when you install Crouse-Hinds EV Lighting Fixtures: quicker installation; quicker relamping; more light. This makes them the best buy for lighting in any location that is hazardous because of the possibility of the presence of flammable atmospheres. Use them on every job and have the best!



3. In relamping only a lamp is carried up and down the ladder and one assembly handled. It is not necessary to stock any spare parts or assemblies for complete convenience.

CROUSE-HINDS COMPANY
Syracuse 1, N.Y.

OFFICES: Birmingham — Boston — Buffalo — Chicago — Cincinnati — Cleveland — Dallas — Denver
Detroit — Houston — Indianapolis — Kansas City — Los Angles — Milwaukee — Minneapolis
New Orleans — New York — Philadelphia — Pittsburgh — Portland, Ore. — San Francisco — Seattle
St. Louis — Tulsa — Washington. RESIDENT REPRESENTATIVES: Albany — Atlanta
Baltimore — Charlotte — Corpus Christi — Richmond, Va. — Shreveport
Crouse-Hinds Company of Canada, Ltd., Toronto, Ont.

TRAFFIC SIGNALS · FLOODLIGHTS

ANCIENT meets MODERN...

Old Chain and Sprocket Pump Jack and VICKERS Modern Long Stroke HYDRAULIC PUMPING UNIT

The chain and sprocket pump jack shown in the foreground is an interesting link with the past. It is pumping a 400 ft well drilled more than 60 years ago.

Back of it is the most modern and efficient pumping unit available today . . . a Vickers Hydraulic Unit pumping from a depth of approximately 7,200 feet. Total well depth is about 9,000 feet.

Vickers Long Stroke Hydraulic Pumping Units provide reliable, efficient, low cost pumping for deep wells. Built in two stroke lengths (20 ft and 30 ft) they have many advantages including: fewer stress reversals, lower stress range, lower acceleration forces, lower peak loads, lower standing valve velocities, constant stroke rate, greater sub-surface efficiency. Results are lower maintenance cost, less down time, increased production and increased profit.

Write for Bulletin 53-51

Vickers Long Stroke Hydraulic Pumping Unit installed in 1953 on Union Oil Company Torrey Well No. 93. Old chain and sprocket jack in foreground is pumping well drilled about 1890.

Vickers Model JV-20400-AV
20-ft stroke length
7 strokes per minute
35,000 lb polished rod load capacity
(Also available in 30-ft stroke)

VICKERS Incorporated

DIVISION OF THE SPERRY CORPORATION

Petroleum Equipment Department

2160 EAST IMPERIAL HIGHWAY • EL SEGUNDO, CALIF.

Offices: 900 E. Second St., Odessa, Texas
317 Thompson Bldg., Tulsa, Okla.

Write for BULLETIN 53-51

6893

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

AVAILABLE JOHNSTON by AL CAPP

WHO IS YO', AN' WHAR IS YO' GOIN'?
AH IS AVAILABLE, AN' HE IS ACCURATE JOHNSTON—AN' WE IS GOIN' T' TEST A OIL WELL!!
SMACK OUT HERE, IN TH' OCEAN?
YAS'M!!—US JOHNSTONS TEST OIL WELLS, ANY-WHAR, ANY TIME—AN' FAST!!
COME BACK!! TELL ME MORE!!
CAIN'T, MA'M!!—WHEN WE GO OUT T' TEST A WELL, WE CUTS LOST DOWN-TIME TO A MINNY-MUM!!

C-548

Copr. Capp Enterprises 1954

JOHNSTON TESTERS

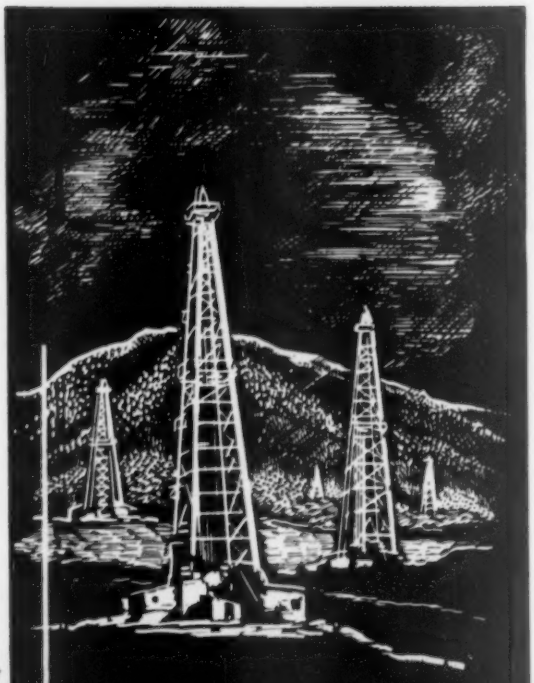
first in drill stem testing

HOUSTON, TEXAS

LOS ANGELES, CALIF. • CALGARY, CAN.

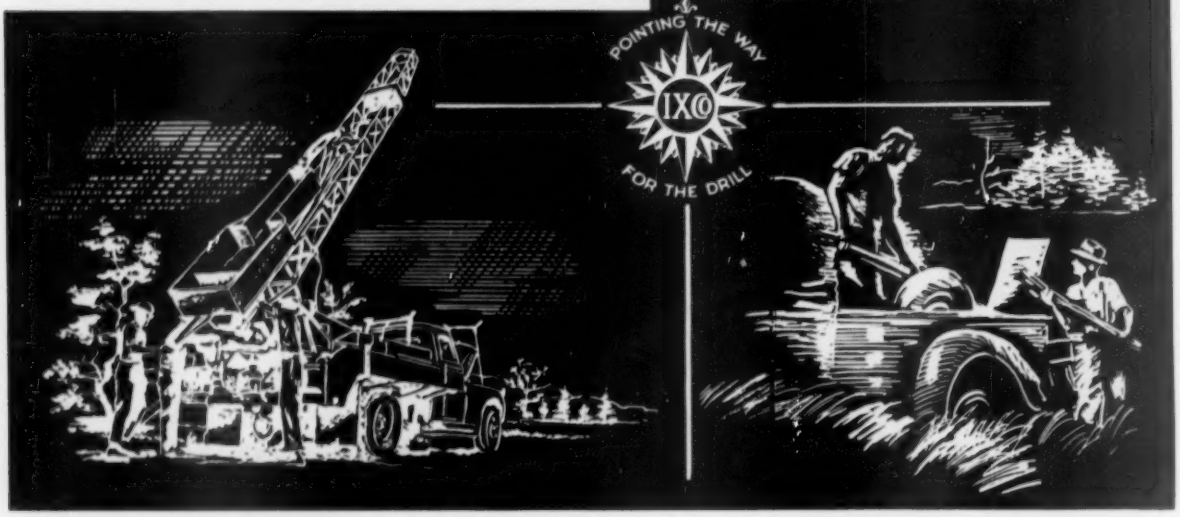
FORMATION AND CASING TESTING — JOHNSTON

Before he became an IX Party Manager, D. D. Doty filled every job on a survey party. He started as a laborer, then successively became a shooter, driller, observer, permit man, and a troop leader. He has now served 21 years with IX.



DERRICKS TODAY

Where I.X. Parties Were Yesterday



IX personnel come from many schools and universities; from all parts of the country. But one thing that they have in common is: Before they reach a responsible position with the company, they have had years of field experience. The "know-how" gained in these years of field work is something extra you get from IX that results in a better geophysical survey for you. For your next survey, be sure of securing results that will pay off for you — call on IX.

Independent

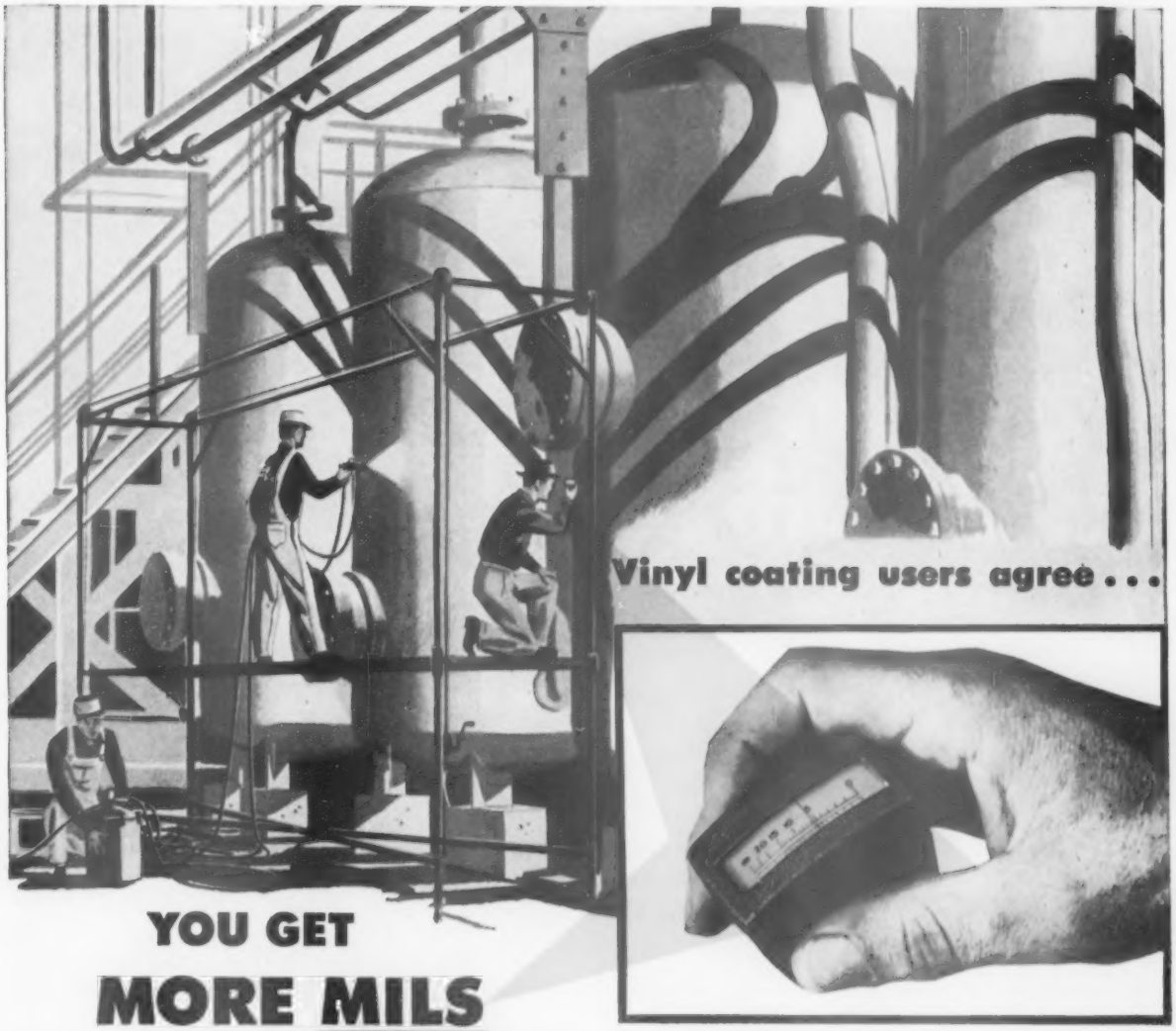
EXPLORATION COMPANY

Geophysical Surveys

1973 West Gray, Houston, Texas

39 Victoria St., London, SW 1, England

Room 8, London Bldg., 620 8th Ave. W., Calgary, Alberta, Canada



Vinyl coating users agree . . .

YOU GET MORE MILS PER GALLON WITH AMERCOAT 33

Amercoat's higher solids content gives you a thicker, heavier coating—more mils for every gallon applied.

THIS MEANS YOU SAVE MONEY TWO WAYS ON MAINTENANCE PAINTING

Lower Material Cost. You save on material because it takes fewer coats of AMERCOAT 33 to build the required film thickness.

Lower Labor Cost. You save on labor because fewer coats mean fewer man hours for application—less down time, too.

In addition to more mil thickness per gallon, you get more protection per gallon. AMERCOAT 33 is formulated specifically for maximum chemical resistance and for severe weathering conditions. In major industries from coast to coast – chemical, petroleum, pulp and paper, food, and many others – maintenance engineers look to AMERCOAT 33 for low cost, long lasting protection for all types of steel or concrete structures.

Amercoat pioneered the development of protective coatings especially designed for severe corrosion problems. Today it is the only organization that offers you... a complete line of corrosion resistant coatings...nationwide distribution... trained technical men to give you on-the-job assistance throughout the United States and Canada.

Amercoat **CORPORATION**
Dept. C
4809 Firestone Blvd.,
South Gate, California

CHICAGO, ILL. • KENILWORTH, N. J. • JACKSONVILLE, FLA. • HOUSTON, TEX.

Write today for the AMERCOAT 33 Technical Bulletin which gives a complete description of the coating's chemical and physical properties.

PIPE LINE PROGRESS

Northern Natural achieves billion cu. ft. daily line capacity... builds with A. O. SMITH LINE PIPE

Northern Natural Gas Company this year completes its expanded two-year construction program, with total daily pipe line capacity up to 1,100,000,000 cu. ft. 460 miles of new main line loops were laid in the two-year program, with twelve sections of loop line being laid each year. New line facilities bring natural gas to 71 additional communities in Iowa, Nebraska, Minnesota and South Dakota . . . so that the company now serves a total of 307 communities in the Northern Plains.

A. O. Smith's participation in the job consisted of 178 miles of 30-inch pipe and 60 miles of 20-inch pipe.

Highly regarded in the industry because A. O. Smith welded steel pipe is consistently accurate in size, roundness and end-to-end matchup. A. O. Smith has supplied all or a part of the line pipe for most major pipe lines in the country.

A. O. Smith Line Pipe is available in a complete range of sizes and wall thicknesses, from 8⅝-in. to 36-in. diameters.

The A.O. Smith Casing Mill is operating at capacity to supply vitally needed casing for the Oil and Gas Industry.

Through research ... a better way

A.O.Smith

CORPORATION

TUBULAR PRODUCTS DIVISION

Milwaukee 1, Wisconsin

Chicago 4 • Dallas 2 • Houston 2 • Los Angeles 22 • Midland 5, Texas • New Orleans 12 • New York 17 • Pittsburgh 19 San Francisco 4 • Seattle 1 • Tulsa 3 • Washington 6, D.C.

International Division: Milwaukee 1

HTL announces the model 7000

. . . the most versatile seismic system available!

Designed to meet your specific requirements, the Houston Technical Laboratories' new Model 7000 provides the greatest versatility of any seismic system ever produced for commercial use. With an AGC control range of 1,000,000 to one, this compact and portable new HTL model is a high gain system (more than 120 decibels) ideally suited for magnetic recording and other special seismic applications.

The HTL Model 7000 gives you unchallenged superiority in distortion control and sensitivity with an input range from 0.1 microvolt to 0.1 volt between 10 and 200 cycles with less than 1% harmonic distortion. Unique filtering flexibility — 1380 filter combinations — plus advanced two-loop Automatic Gain Control add to the versatility of this new seismic system. AGC speed control on each channel provides a choice of three positions — slow, medium, or fast.

- 1,000,000 to 1 dynamic range
- input signals as low as 0.3 microvolt saturate AGC (AGC threshold 0.1 microvolt)
- 1380 possible filter combinations
- negligible distortion up to 0.1 volt input
- ideally suited for magnetic recording
- module construction for portable or vehicle use
- three AGC speed positions on each channel
- linear, time-varied gain, or AGC operation
- built-in complete testing facilities

WRITE for HTL Bulletin No. S-304 for more detailed information about this completely new development in seismic instrumentation. Model 7000 systems now in production and available.

HTL

HOUSTON TECHNICAL LABORATORIES

A SUBSIDIARY OF TEXAS INSTRUMENTS INCORPORATED

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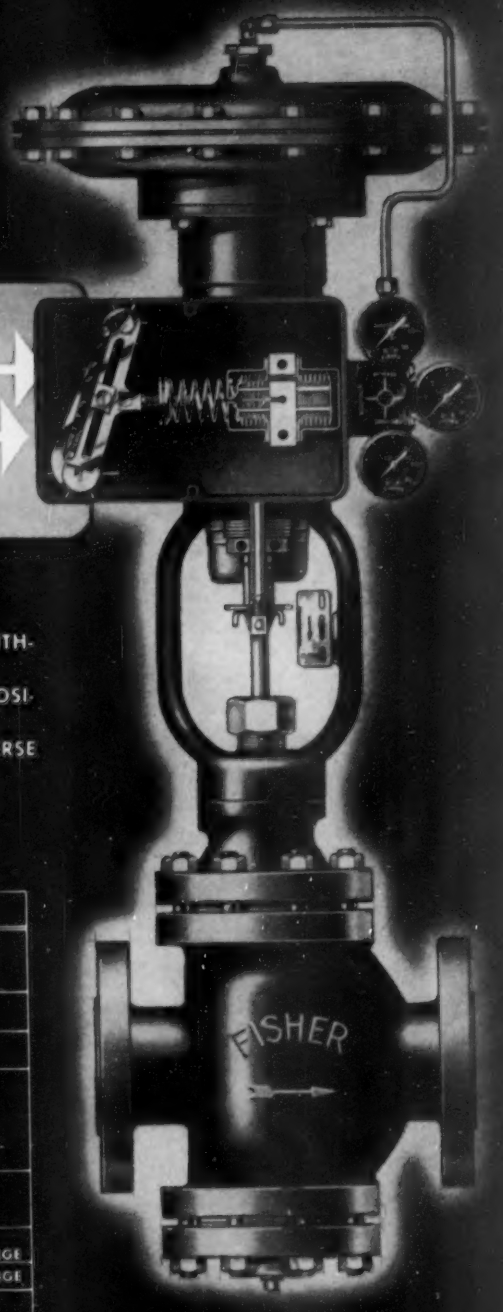
FISHER®

POSITROL®

FOR ACCURATE POSITIVE VALVE POSITIONING



FEATURES

- COMPACT — SIMPLE, RUGGED
- 5 YEARS FIELD SERVICE
- EASILY ADJUSTABLE
- FORCE BALANCE TYPE OF POSITIONER
- AVAILABLE WITH OR WITHOUT BY-PASS
- USABLE AS REMOTE POSITION INDICATOR
- FOR DIRECT OR REVERSE ACTION VALVES

TECHNICAL DATA

TEST			FISHER TYPE 3500
INSTRUMENT PRESSURE SENSITIVITY CONTROLLING PRESSURE CHANGE NEEDED TO PRODUCE 2 LBS. TO 15 LBS. TO DIAPHRAGM			0.07 LB
STEM MOVEMENT SENSITIVITY AMOUNT STEM CHANGE TO PRODUCE 2 LBS. TO 15 LBS TO DIAPHRAGM	½" TRAVEL		0.0037" AVE.
	2" TRAVEL		0.015" AVE.
SPEED TIME IN SECONDS FOR FULL TRAVEL	SIZE	TRAVEL	
	DD	¼"	1.2 — 1.2 SEC.
	FF	1½	4.2 TO 4.8 SEC.
	GG	2	7.2 SPC TO 9.6 SEC.
	HH	2	10.5 TO 12.6 SEC.
LAG ERROR IN POSITION AT 9 LBS. CONTROLLER PRESSURE	½" TRAVEL		0.0006" AVE.
	2" TRAVEL		0.001" AVE.
EFFECT OF VARIATIONS IN AIR SUPPLY PRESSURE	½" TRAVEL		0.1 LB. PER 5 LB. CHANGE
	2" TRAVEL		0.1 LB. PER 5 LB. CHANGE
CHARACTERISTICS CONTROLLED P VS. DIAPHRAGM P			LINEAR
COMMENTS			STABLE ADJUSTMENTS ALL EASY AND SIMPLE
AIR CONSUMPTION NORMAL 9 LBS. DIAPHRAGM PRESSURE			15.0 CU FT/HR

FOR COMPLETE DETAILS WRITE FOR BULLETIN E-3500

FISHER
GOVERNOR COMPANY
Marshalltown, Iowa

LEADS THE INDUSTRY IN RESEARCH FOR BETTER PRESSURE CONTROL

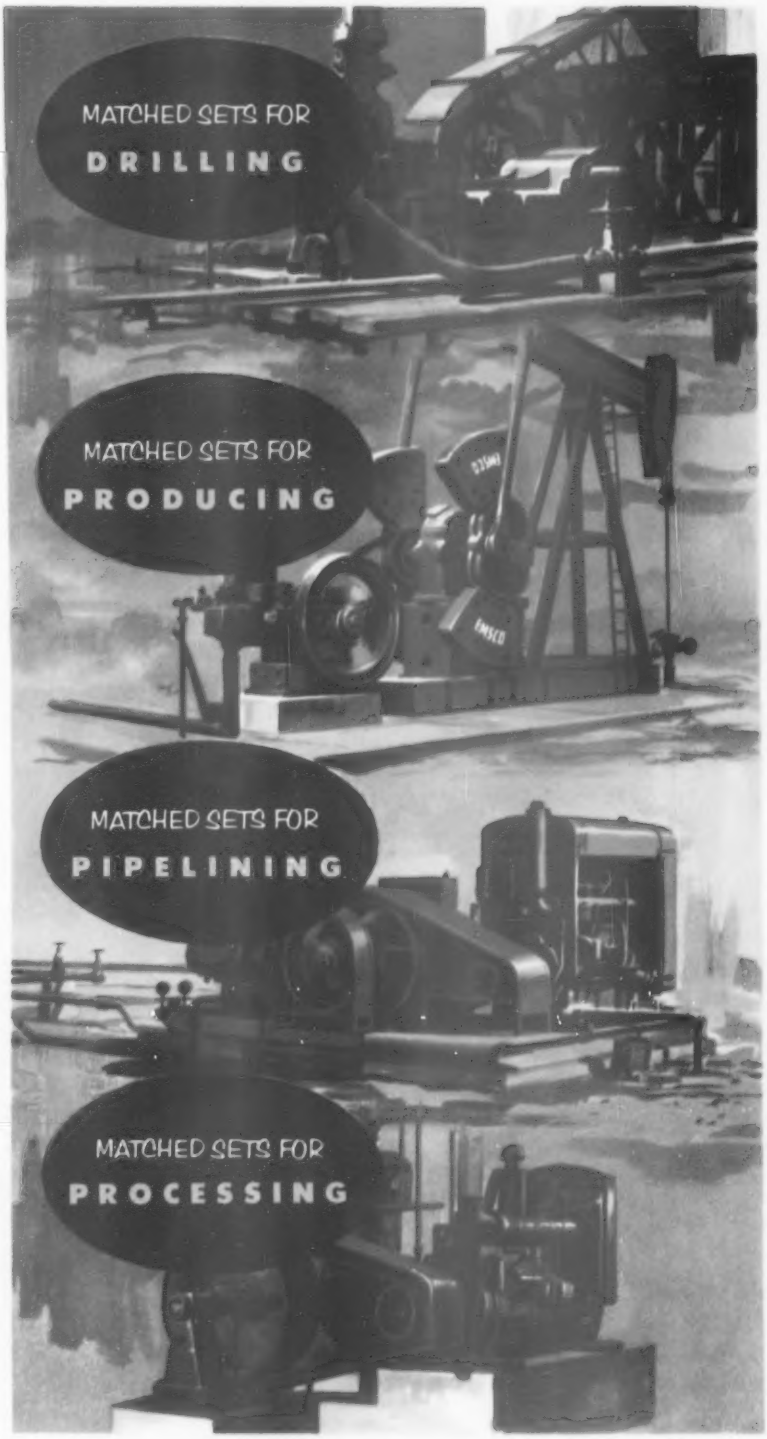
Since 1880

Whatever the application

TEST SPECIAL V-BELTS

are available in

MATCHED SETS



The performance quality of New York Belting & Packing Company's Test Special V-Belt is supported by Continental's unsurpassed service.

This V-Belt service is two-fold:

1. Complete stocks available in matched sets at all Continental stores and,
2. The assistance of V-Belt specialists in the selection of the proper belts for the job and experienced advice in correct installation and maintenance.

CONTINENTAL

Serving the Oil and Gas Industries

NEW YORK BELTING & PACKING CO. Founded 1846

THE CONTINENTAL SUPPLY COMPANY

General Offices: DALLAS, TEXAS

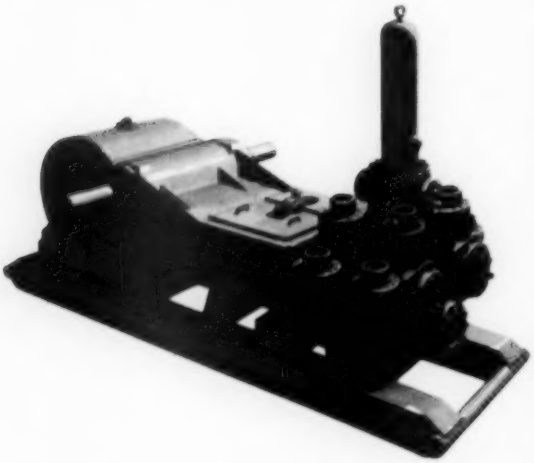
Representatives in All Principal Oil Fields of the World

Presenting

12 MORE REASONS WHY

GARDNER-DENVER MUD PUMPS

GIVE CONSISTENT, DEPENDABLE PERFORMANCE



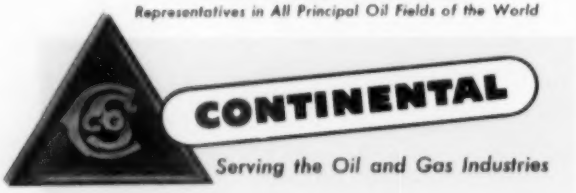
With a Gardner-Denver Mud Pump on a rig there is the maintenance assistance of factory-trained, field-experienced Gardner-Denver Specialists. Each of these men is fully qualified to help keep Gardner-Denver Mud Pumps operating at top efficiency.

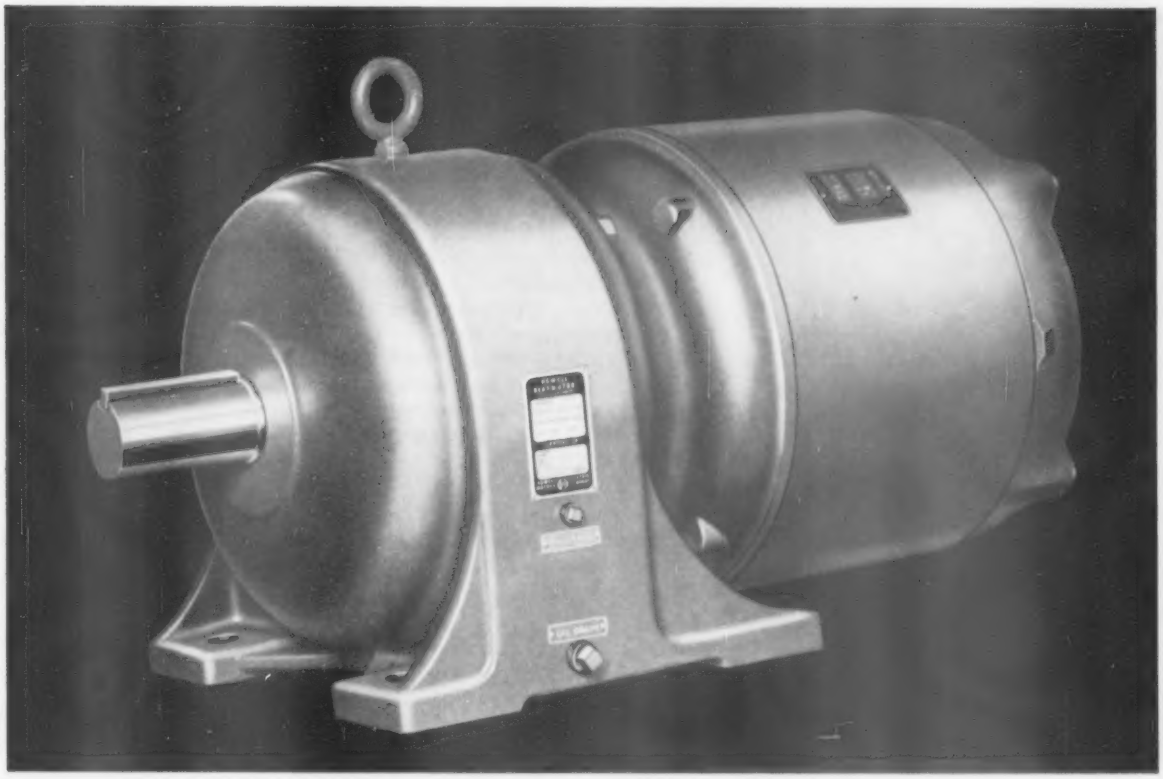
These Specialists are strategically located throughout the oil country and readily available at all times.

THE CONTINENTAL SUPPLY COMPANY

General Offices: DALLAS, TEXAS

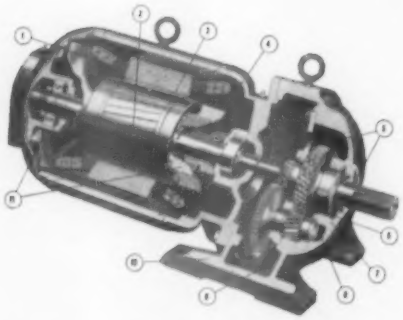
Representatives in All Principal Oil Fields of the World





The power you need at the speed you need it . . .

HOWELL GEAR MOTORS



11 reasons why Howell Gear Motors last longer, serve you better

1. High-quality insulation
2. Copper-clad rotor
3. Expert craftsmanship
4. High-quality coil varnish
5. Leakproof oil seals
6. Duti-Rated Lifetime Gearing
7. Unit case construction with integral bearing housings
8. Corner-mounted offset shaft
9. Large oil reservoir
10. Heavy, cast-iron construction
11. Superior cooling

New dependability, greater starting torque and top efficiency, with output speeds as low as 7.5 rpm. are now available in Howell Gear Motors.

This compact, single-unit motor may well be the answer to your gear reduction problems. Combining the finest in heavy duty industrial gearing with the best in motoring, Howell Gear Motors reduce drive failures and production downtime.

Howell Gear Motors use duti-rated, lifetime gearing, with file-hard tooth surfaces and tough, resilient cores. They are available in all types of enclosures, from 7.5 to 780 rpm. with a capacity range from 1 to 150 hp., in all three AGMA service classifications.

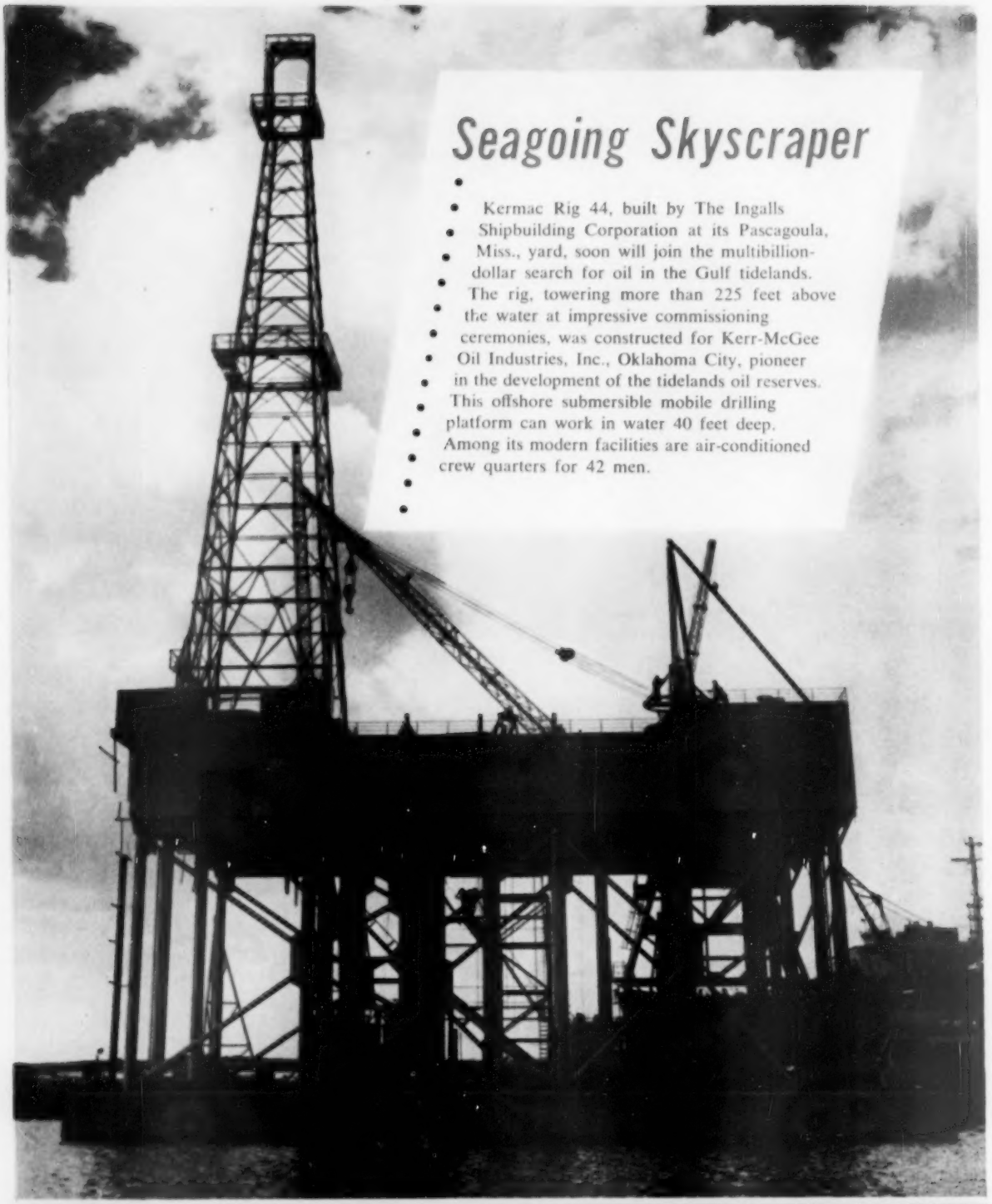
For full information on Howell Gear Motors, contact the Howell man in your area, or write the factory direct for Bulletin GM-1.

HOWELL Red Band MOTORS

HOWELL MOTORS

HOWELL ELECTRIC MOTORS COMPANY, HOWELL, MICHIGAN

MOTORS FOR INDUSTRY SINCE 1915



Seagoing Skyscraper

Kermac Rig 44, built by The Ingalls Shipbuilding Corporation at its Pascagoula, Miss., yard, soon will join the multibillion-dollar search for oil in the Gulf tidelands. The rig, towering more than 225 feet above the water at impressive commissioning ceremonies, was constructed for Kerr-McGee Oil Industries, Inc., Oklahoma City, pioneer in the development of the tidelands oil reserves. This offshore submersible mobile drilling platform can work in water 40 feet deep. Among its modern facilities are air-conditioned crew quarters for 42 men.

BUILDERS OF:
TANKERS • OIL BARGES
MARINE EQUIPMENT
OIL DRILLING BARGES
MARINE BULK STORAGE
TANKS • OIL AND CHEMICAL
STORAGE TANKS

RIG NO. 44

THE INGALLS SHIPBUILDING CORPORATION

General Offices: Birmingham, Alabama, U.S.A.
Shipyards: Pascagoula, Mississippi — Decatur, Alabama
Branch Offices: New York, Pittsburgh, Chicago, Houston, Washington, D. C., New Orleans

Here is the most complete fire protection program ever offered

TRAINING FOR YOUR PERSONNEL at your plant is provided by Ansul fire control experts without cost to you.

VISUAL AIDS for your safety meetings designed to make all your employees fire-control conscious.

CUSTOMER SCHOOL AT MARINETTE—best equipped fire control school available for training your key safety personnel.

COMPLETE PLANT SURVEY provided by Ansul is designed to give you the best fire protection possible at the lowest cost.

Ansul Fire Equipment is Faster, More Effective

A positive activating system puts Ansul's "Plus-Fifty" dry chemical to work immediately. To insure full fire coverage, patented nozzles deliver the right kind of stream for your fire protection problem (low velocity or long range). Ansul extinguishers are water-tight, corrosion resistant, always ready for action, even after extreme weathering. Quality features like these make it possible for Ansul to back their equipment with a 5-year warranty.

Call the Ansul Man!

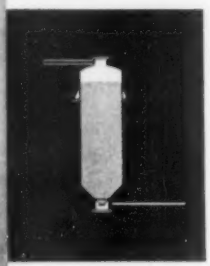
Get in touch with your local Ansul man through the "yellow pages" or write ANSUL CHEMICAL COMPANY, Fire Equipment Division, Department F-94, Marinette, Wisconsin.

ANSUL

ATTAPULGUS Fullers Earth

POROCEL Activated Bauxites

. . . reliable sorptive minerals for petroleum and chemical processing



WANT TO PURIFY BY ADSORPTION?

There's an Attapulgus or Porocel adsorbent to fit your process technique for removing odors, colors, tastes, moisture, acids, sulfur, fluorides and unsaturates from process liquids or gases. Materials treated in principal applications are: motor oils and other lubricating, specialty, and technical oils; petrolatums and waxes; aviation and motor gasoline stocks; kerosene; diesel and heating oils; chemicals and petrochemicals.

HAVE CATALYST OR CATALYST CARRIER NEEDS?

Our sorptive minerals are recognized standards in desulfurization, reforming and isomerization systems—catalytic removal of unsaturates—conversion of sulfides to elemental sulfur—fluid catalyst applications—as catalyst carrier in copper sweetening processes.

WHAT DO YOU WANT TO DRY?

We offer a wide range of reliable, thoroughly proved desiccants for drying air, hydrogen, carbon dioxide, hydrocarbon liquids and gases.

SPECIAL GRADES

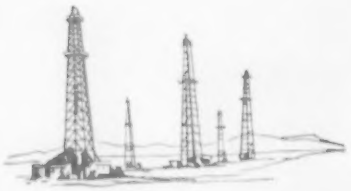
Mine and plant facilities permit prompt and economical production of grades meeting individual customer specifications. Our laboratories and technical staffs are ready to assist in research, development, design and operating problems. Your inquiries are invited.

ATTAPULGUS DIVISION
Minerals & Chemicals Corporation of America

POROCEL
Corporation

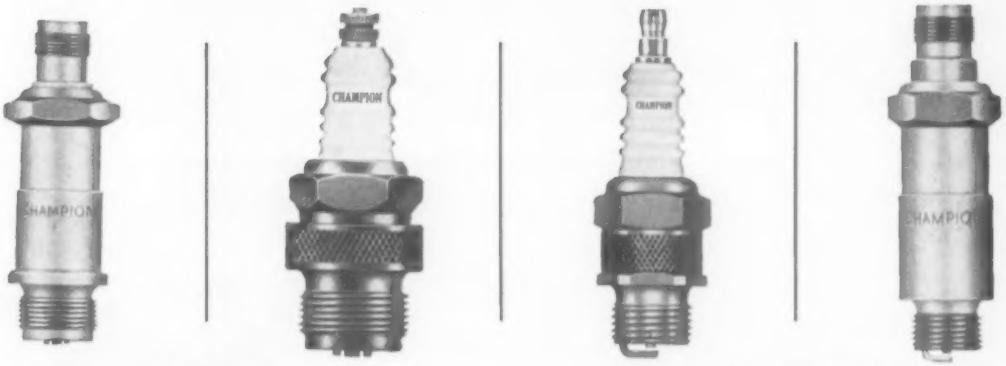
DEPT. V, 210 WEST WASHINGTON SQUARE, PHILADELPHIA 5, PA.

CHAMPION

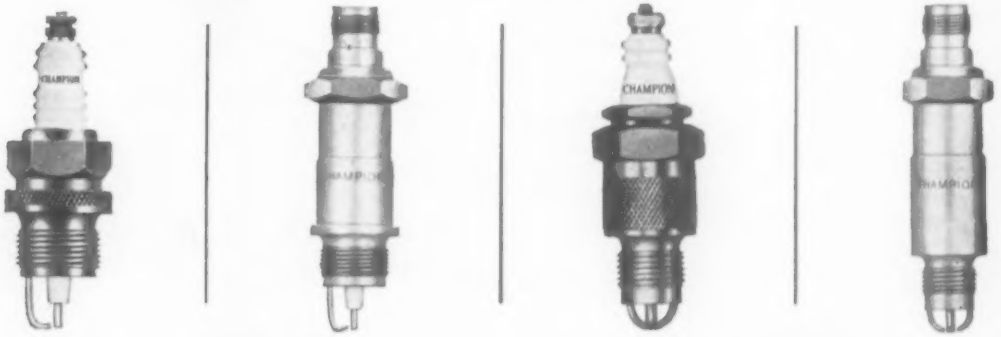


INDUSTRIAL AND OIL FIELD SPARK PLUGS HAVE A WORLD-WIDE REPUTATION FOR

Long Life and Best Performance!



E-901 **GAS ENGINE** 901 6 COM. **GASOLINE UNITS** E-6 COM.



44 **DIESEL STARTING** E-44 D-8 **HESSELMAN** ED-8

Shielded or unshielded to best suit your safety requirements, Champions are precision engineered for the specific job and have earned a reputation for long, trouble-free service life under the toughest conditions.

Only Champion offers a complete line of spark plugs for all industrial and oil field engines, gasoline, natural gas, Hesselman and diesel.

BEST FOR ANY ENGINE

CHAMPION

SPARK PLUGS

CHAMPION SPARK PLUG COMPANY, TOLEDO 1, OHIO

J&L STEEL

Midwest

WELDING FITTINGS

MIDWEST Welding Fittings made of easy-to-weld JALTEN are ideal for use with the new high-tensile, high-yield pipe now being placed in oil and gas transmission service.

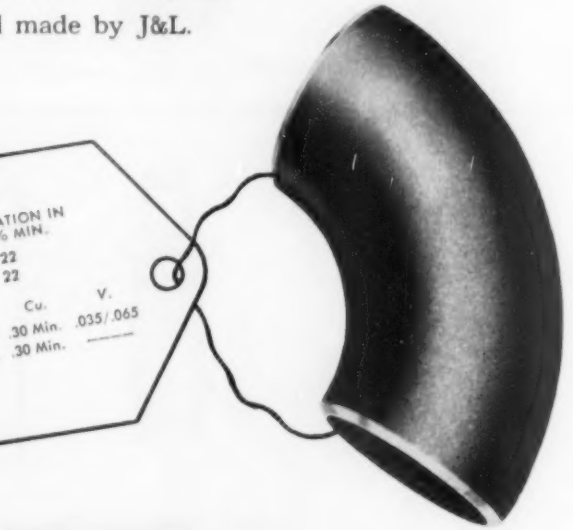
JALTEN is a new low-alloy high-strength steel made by J&L.

JALTEN PHYSICAL PROPERTIES:

	YIELD POINT P.S.I. MIN.	TENSILE STRENGTH P.S.I. MIN.	ELONGATION IN 2", % MIN.
Jalten #1	50,000	65,000	22
Jalten #2	50,000	70,000	22

CHEMISTRY	C	M	P	S	Si	Cu.	V.
Jalten #1	.15 Max.	1.30 Max.	.04 Max.	.05 Max.	.10 Max.	.30 Min.	.035/.065
Jalten #2	.15 Max.	1.40 Max.	.14 Max.	.05 Max.	.10 Max.	.30 Min.	———

Jalten #2 Equivalents: SAE 950
ASTM-A242-49T



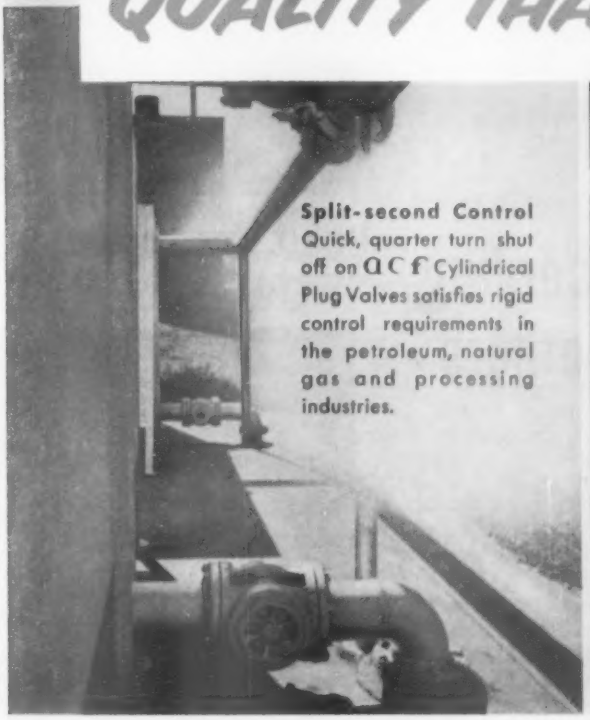
Jones & Laughlin
STEEL CORPORATION
SUPPLY DIVISION – TULSA, OKLAHOMA
Serving The United States and Canada

Knife-edge Rotary Action of the acf Cylindrical Plug Valve clears obstructions, eliminates stoppages, insures constant flow.

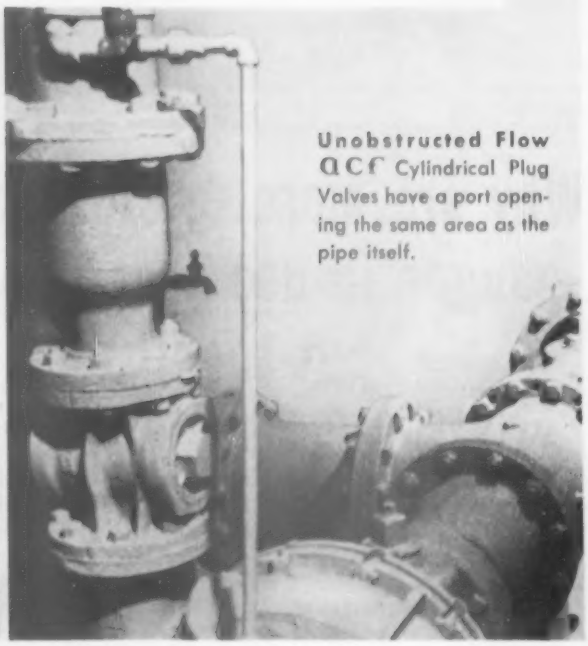
Head Leakage Control vital to maximum dependability is assured on acf Cylindrical Plug Valves by a specially designed **TEFLON® GASKET.**

*TEFLON IS A DUPONT PRODUCT

QUALITY THAT PAYS OFF



Split-second Control Quick, quarter turn shut off on acf Cylindrical Plug Valves satisfies rigid control requirements in the petroleum, natural gas and processing industries.



Unobstructed Flow acf Cylindrical Plug Valves have a port opening the same area as the pipe itself.

Rectangular Port *and* **Full Round Port**

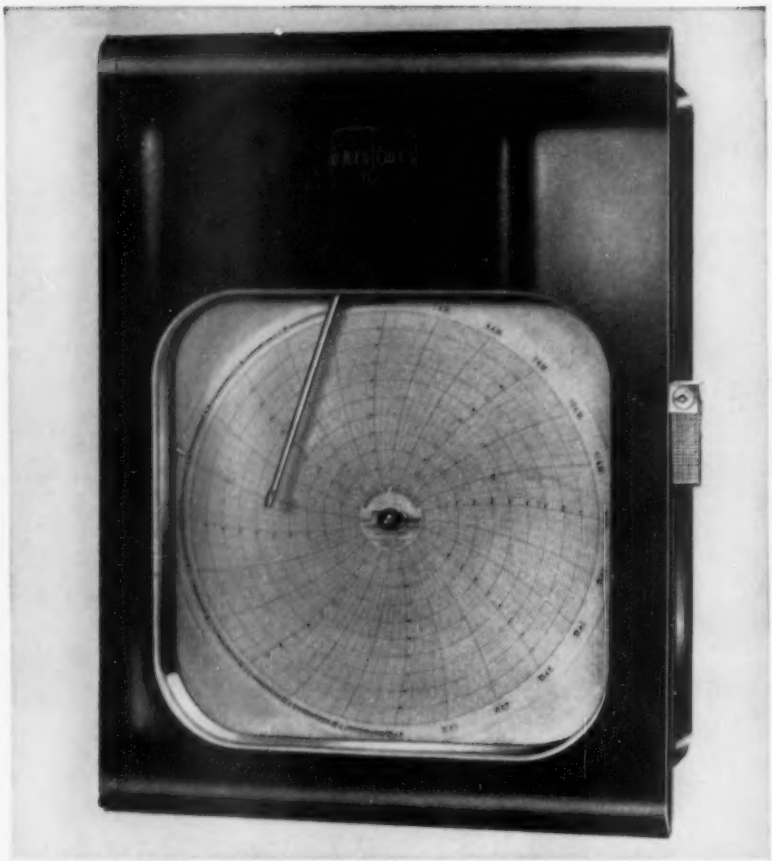
acf

Representatives in 50 Principal Cities

CYLINDRICAL FULL PIPE AREA

PLUG VALVES

Write for descriptive Catalog 5-OG to acf Industries, Incorporated, Valve Division, 1501 E. Ferry Avenue, Detroit 11, Michigan.



EASY-TO-USE BRISTOL RECORDING GAUGES come in pressure ranges from 0 - 0.2 inch of water to 0 - 10,000 psi. Vacuum gauges are available in various ranges from 0 - 30 inches of mercury and absolute pressure gauges in ranges as low as 0 - 6 mm mercury absolute.

Why are more Bristol recording gauges in use than all others put together?

• That's easy — accuracy and dependability are the reasons.

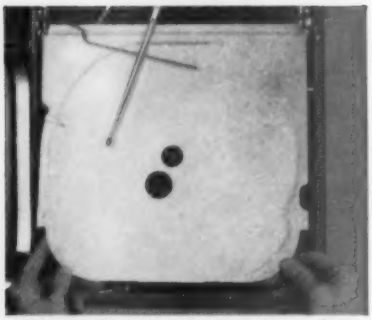
For accuracy, Bristol's measuring elements are unsurpassed. They are the product of 65 years of research and development. Bristol engineers are constantly engaged in developing pressure and vacuum measuring elements of higher accuracy, greater sensitivity, and increased stability.

As for dependability, many Bristol gauges have been in constant operation for more than 40 years — without special attention of any kind!

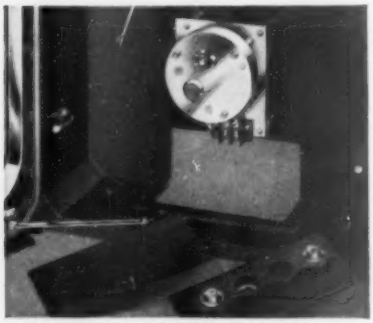
You can get the Series 500 gauge in models designed for recording, controlling and telemetering. Write today for free 32-page Bulletin G621. The Bristol Company, 120 Bristol Road, Waterbury 20, Conn.

Many ranges carried in stock for immediate delivery

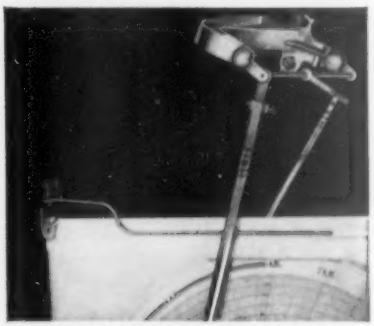
LOOK AT THESE "HUMAN-ENGINEERED" FEATURES!



SNAP-ON TYPE CHART PLATE — No tools are needed to remove chart plate. Spring, finger release permits quick access to the space beneath the chart. Plate is easily replaced.



UNIVERSAL CONNECTION BLOCK — Mounting block for instrument connections easily changed from bottom to back of case or vice versa; measuring system can be removed or replaced.



PEN LIFTER — Simple, non-obscuring pen lifter, mounted independently of the chart plate, raises pen from the chart, provides complete freedom for working on instrument with chart plate removed.

BRISTOL

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

Underwriters' Laboratories, Inc.

INSPECTED

TYPE EX POWER-OPERATED
INDUSTRIAL TRUCK
FOR HAZARDOUS LOCATION
CLASS 1 GROUP D NO. 101

Designed not only for safety but also economy . . .

Clark's new EXPLOSION-PROOF Carloader

Clark's electric Explosion-Proof Carloader was specifically designed to meet the rigid requirements of Underwriters' Laboratories, Inc. It was the first lift truck to receive Type EX, Class I Group D approval. It is safe for operation in atmospheres containing explosive fumes and vapors, such as gasoline, lacquer, propane.

This truck was not merely modified to meet these rigid requirements—it was engineered from the ground up. Although it is rated at 3, 4, or 5000 lbs. capacity, its frame is all-welded, integral unit plate steel comparable to those required for much heavier loads. There is ample space for the larger motor and components which Underwriters' Lab requires for "EX" equipment. Forks are solid bronze; bumper plates are wooden.

In addition to *Safety*, the new Explosion-Proof Carloader provides outstanding economy and battery efficiency. It utilizes the same basic control system which enables *all* Clark electrics to outperform other equipment—to work a longer cycle without recharging batteries.

We invite you to compare the new Explosion-Proof Carloader with any comparable truck on the market. Call your local Clark dealer—listed in the Yellow Pages. Or write for details.

CLARK EQUIPMENT

Industrial Truck Division
CLARK EQUIPMENT COMPANY
Battle Creek 158, Michigan

☐ Send details on "EX" Carloader

Name_____

Firm Name_____

Street_____

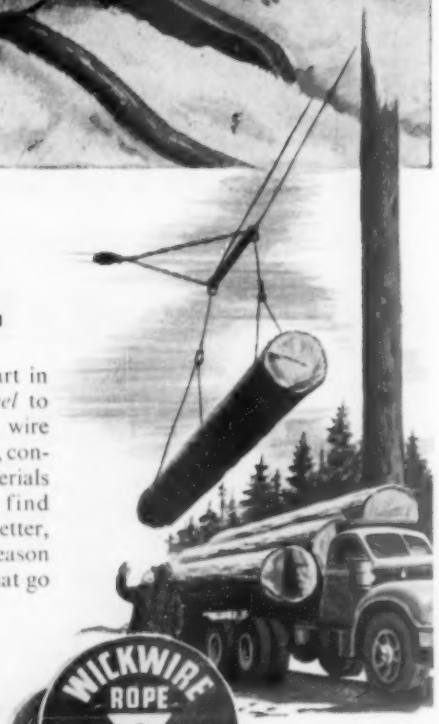
City_____ Zone_____ State_____

now—the logs are lighter with MUSCLES OF STEEL

Gone are the days when muscles of man and beast were the only means of loading and hauling big timber out of the woods. Supplying present-day lumber needs is a job that would lick ten thousand Samsons.

It's a job that demands *muscles of steel*—rugged wire rope that lifts and pulls the heaviest logs with strength to spare.

We of Wickwire play a big part in furnishing these *muscles of steel* to American industry. Wherever wire rope is used—timbering, drilling, construction, mining, fishing, materials handling—there also you'll find Wickwire Rope helping to do a better, more efficient job. That's the reason for the quality and extra care that go into its making.



***every** industry benefits from wire rope*

WICKWIRE ROPE

CF&I PRODUCT OF WICKWIRE SPENCER STEEL DIVISION
THE COLORADO FUEL AND IRON CORPORATION

2535

THE COLORADO FUEL AND IRON CORPORATION—Alabama (Tex.) • Denver • Houston • Odessa (Tex.) • Phoenix • Salt Lake City • Tulsa
PACIFIC COAST DIVISION—Los Angeles • Oakland • Portland • San Francisco • Seattle • Spokane
WICKWIRE SPENCER STEEL DIVISION—Boston • Buffalo • Chattanooga • Chicago • Detroit • Emlenton (Pa.) • New Orleans • New York • Philadelphia

When you want

BETTER PERFORATING

listen to what operators say:

"Even on tough jobs, Lane-Wells perforating gets results for me."

"Their depth measurements are on the nose!"

"They don't waste my time or theirs — they arrive on time, rig up fast, do the job and clear out of the way."

"Lane-Wells men *know* my well conditions and how to meet 'em."

"You can depend on what they tell you. No double talk, no alibis if anything goes wrong — they just make good."

"I like the careful way Lane-Wells crews operate . . . safety's a big point with me."

CALL

LANE WELLS COMPANY

TECHNICAL OIL FIELD SERVICES

Tomorrow's Tools - Today!

BZ-81-A

General Offices, Export Office and Plant • 5610 So. Soto St. • Los Angeles 58, California

Los Angeles • Houston • Oklahoma City • Lane-Wells Canadian Co. in Canada • Petro-Tech Service Co. in Venezuela

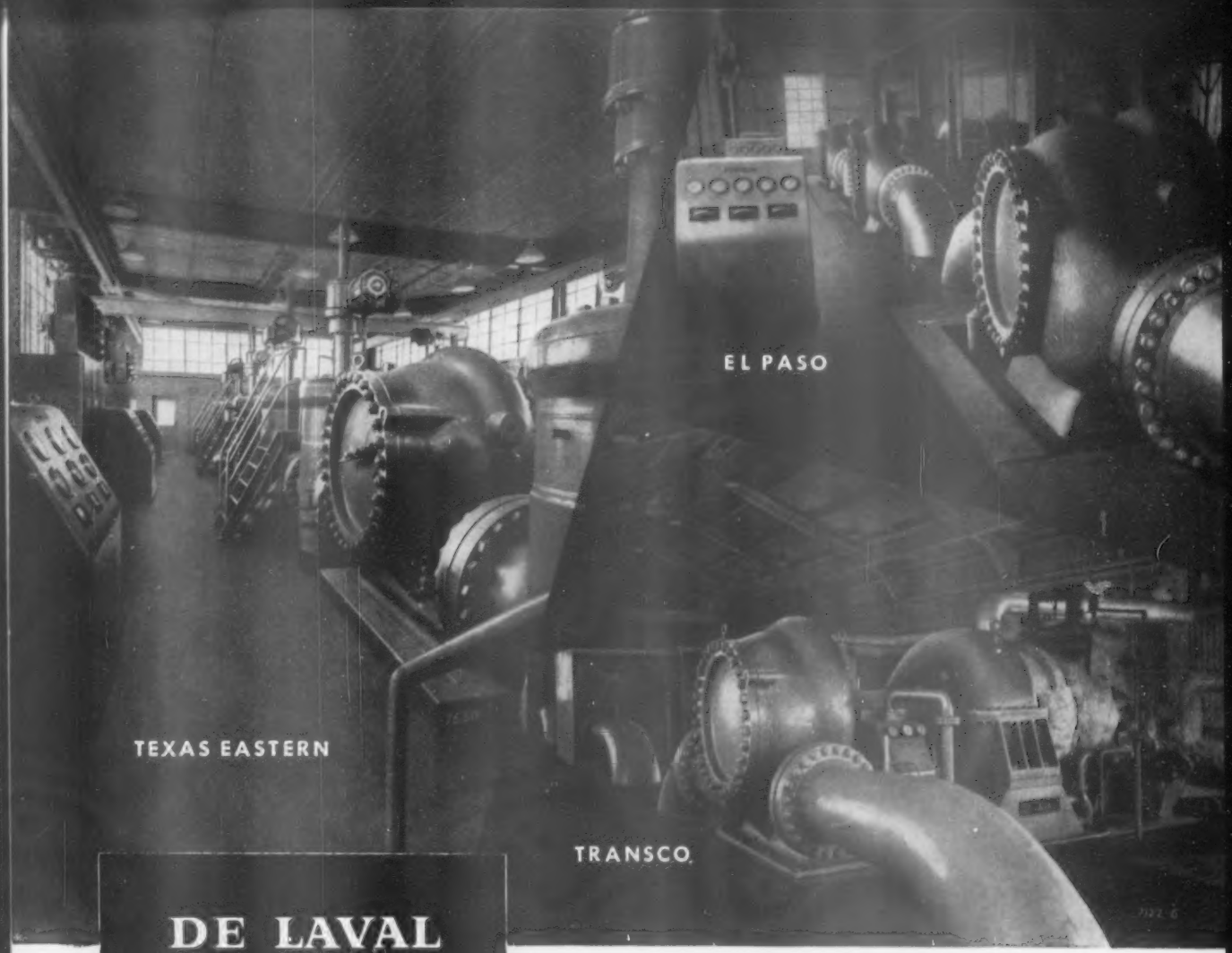
Be sure with Pure

Producers • Refiners • Marketers

of petroleum products

THE PURE OIL COMPANY

Marketing Offices in Principal Cities of the Eastern, Central and Southern States
General Offices, Chicago, Illinois



DE LAVAL CENTRIFUGAL COMPRESSORS *do a big job for gas pipelines*

High pressure gas transmission on pipelines calls for equipment that's dependable as well as efficient. That's why De Laval centrifugal compressors have been chosen for these and many other booster stations.

De Laval centrifugal compressors offer important engineering features. ● Pressure contact shaft seal eliminates gas leakage. ● Construction is heavy and rigid throughout. ● Units have high load carrying capacity. ● They can be designed to handle an increased ultimate flow.

De Laval units, totaling 200,000 hp, are now in operation on major pipelines. De Laval engineers will be glad to give you the benefit of their wide experience in this field.

TRANSCO selected these three De Laval 5,000 hp steam turbine-driven centrifugal compressors for their Tylertown, Mississippi station.

EL PASO—These 30-inch De Laval centrifugal compressors are on the job at El Paso's Florida station. In addition, they have nine more De Laval units in use at other stations.

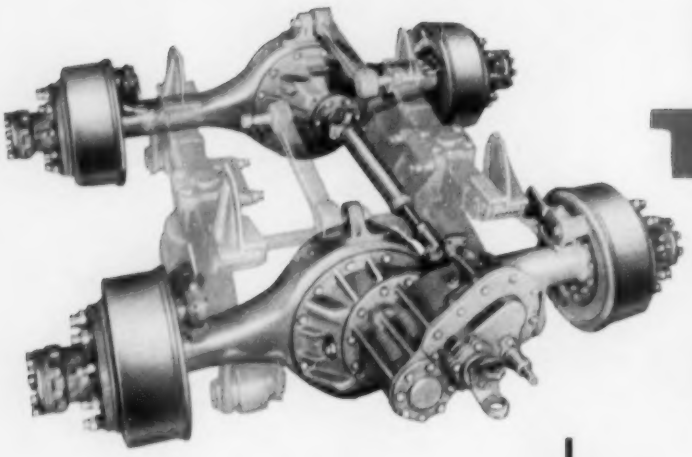
TEXAS EASTERN—The thirteen 2,500 hp centrifugal compressors on this company's 30-inch gas pipeline from Kosciusko, Mississippi, to Uniontown, Pennsylvania, are all De Laval.

DE LAVAL *Centrifugal Compressors*

DE LAVAL STEAM TURBINE COMPANY

810 Nottingham Way, Trenton 2, New Jersey

SIX reasons for the superior performance of EATON TANDEM DRIVE AXLES



1 Designed Specifically for Tandem Operation,
Eaton Tandem Axles are not subject to abnormal stresses or complicated lubrication problems.

2 Single Drive Line
on a normal angle gives a direct lead from power divider to rear axle; simplifies design, eliminates excess parts, minimizes maintenance.

3 Rugged Power Divider
mounted on forward axle, is of simple design; provides for transmission of power equally to both axles.

4 Inter-Axle Differential
in power divider assures equalized power transmission even though wheel speed may vary due to road irregularities or tire diameter variations.

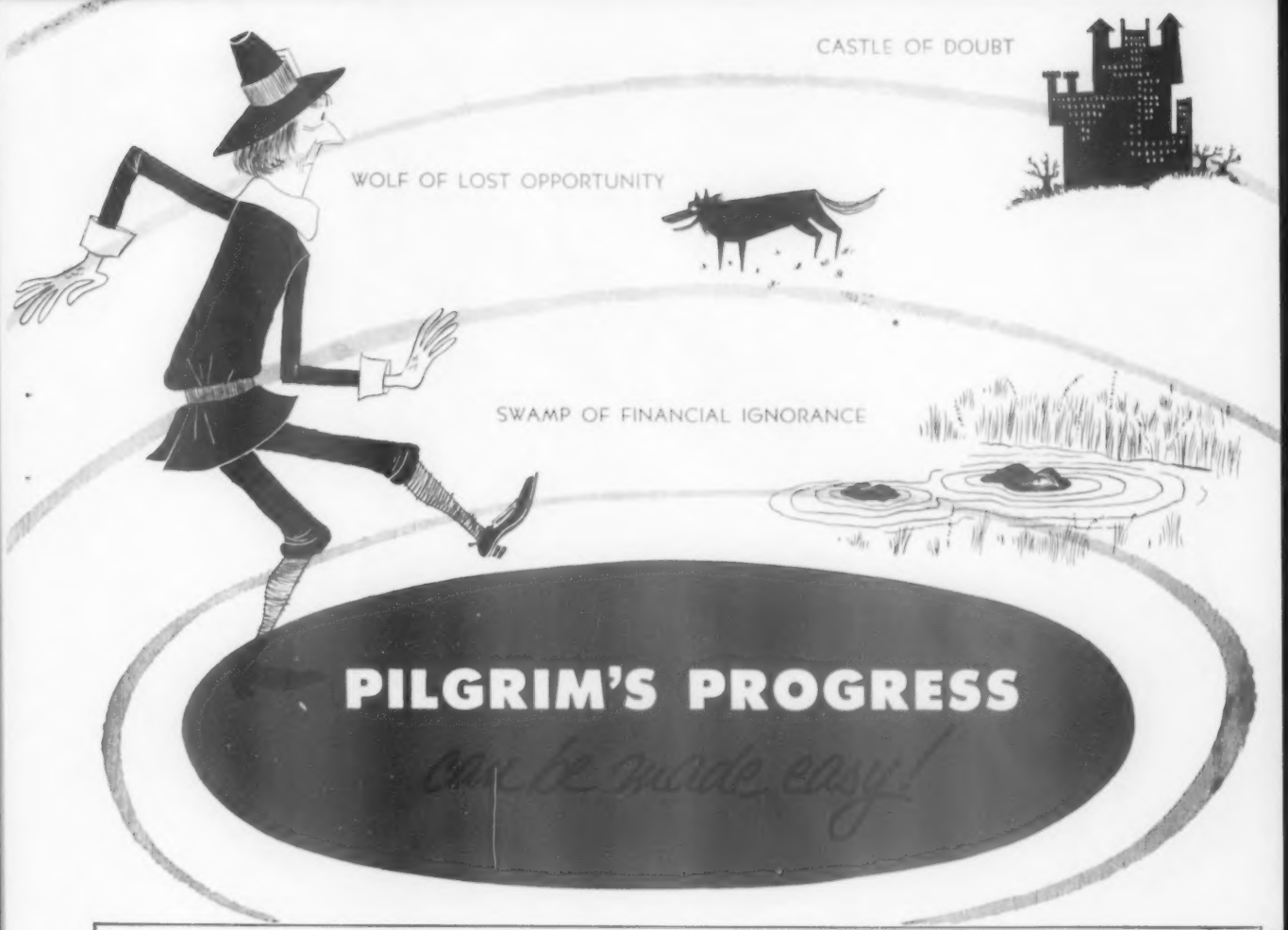
5 Differential Lock-out
between forward and rear axles (optional on some models) provides positive drive to each of the axles, when required because of soft or slippery road conditions.

6 Maximum Strength with Minimum Weight
is achieved through simplified design, experienced engineering, and accurate fabrication.

Ask your truck dealer to explain how Eaton Tandem Drive Axles provide trucks with greater load capacity — reduce tire and operating costs.

EATON AXLE DIVISION
MANUFACTURING COMPANY
CLEVELAND, OHIO

PRODUCTS: Sodium Cooled, Poppet, and Free Valves • Tappets • Hydraulic Valve Lifters • Valve Seat Inserts • Jet Engine Parts • Rotor Pumps • Motor Truck Axles • Permanent Mold Gray Iron Castings • Heater-Defroster Units • Snap Rings Springtites • Spring Washers • Cold Drawn Steel • Stampings • Leaf and Coil Springs • Dynamatic Drives, Brakes, Dynamometers



The progress of your business depends on your ability to plan ahead — to plan for future, orderly growth. The proved experience of officers of The National Bank of Commerce can help you in making these plans. And they can help you to keep your business running smoothly. The National Bank of Commerce has every modern banking facility available for its industrial depositors. You can put these complete services to work for you when you make The National Bank of Commerce of Houston your bank.

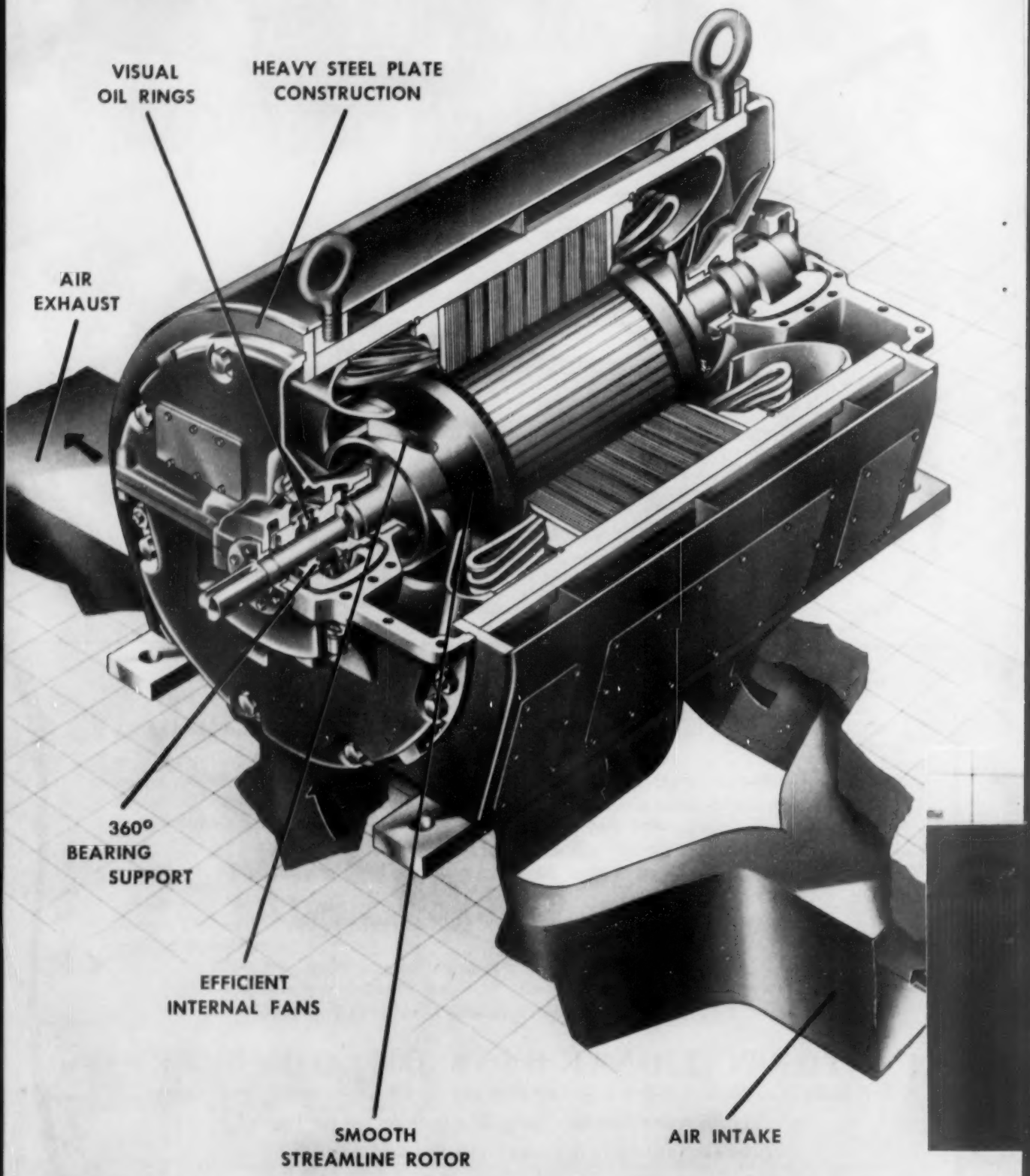
THE NATIONAL BANK OF COMMERCE

OF HOUSTON

Gulf Building, Houston, Texas "The Bank for All the People"

MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

G-E two pole motor typical of construction below 1000 h.p.



G-E enclosed base-ventilated motors eliminate ugly piping; need no firewall

Here's a motor that improves the appearance of your pipe-line pumping station. General Electric's enclosed base-ventilated motor has air intake and discharge ducts located below floor level eliminating unsightly piping.

General Electric enclosed base-ventilated motors are built without limitation in size and give you the advantages of low cost and all-around protection. Here are some of the features that make this motor particularly suitable for pipe-line pumping applications.

SIMPLE, ECONOMICAL INSTALLATION possible because no intervening firewall is needed. This means reduced station construction costs. Also, a more direct connection between motor and pump results in freer movement around motors.

SEPARATE MOTOR-DRIVEN BLOWERS started up in advance purge the motor and duct system of any gases that may have accumulated during a shutdown period. It also removes excess motor heat from the station without the use of additional equipment.

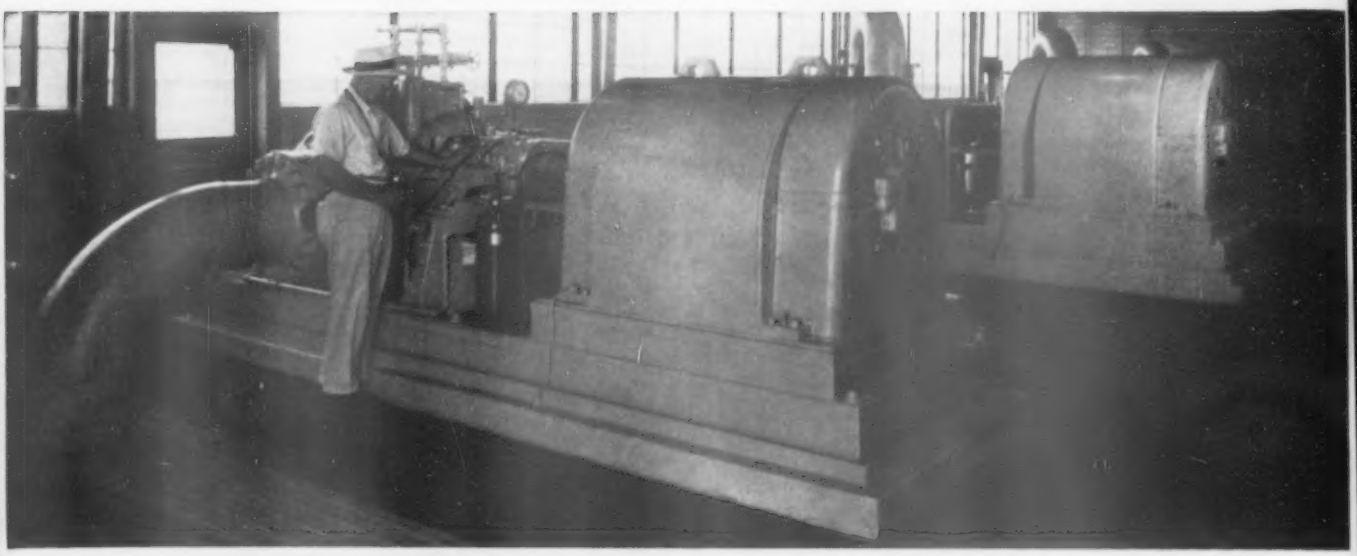
BASE VENTILATION with intake and discharge ducts opening directly down through the foundation to the source of ventilating air minimizes the possibility of hazardous leaks from exposed pipe joints.

A WIDE SELECTION from General Electric's complete line of pipe-line motors assures you of getting the right motor for every application. For more information on G-E enclosed base-ventilated motors or any of the complete line, contact your nearest Apparatus Sales Office. *General Electric Co., Schenectady 5, N.Y.*

855-12

Progress Is Our Most Important Product

GENERAL ELECTRIC

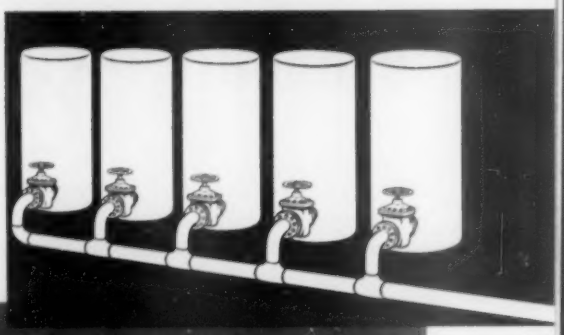


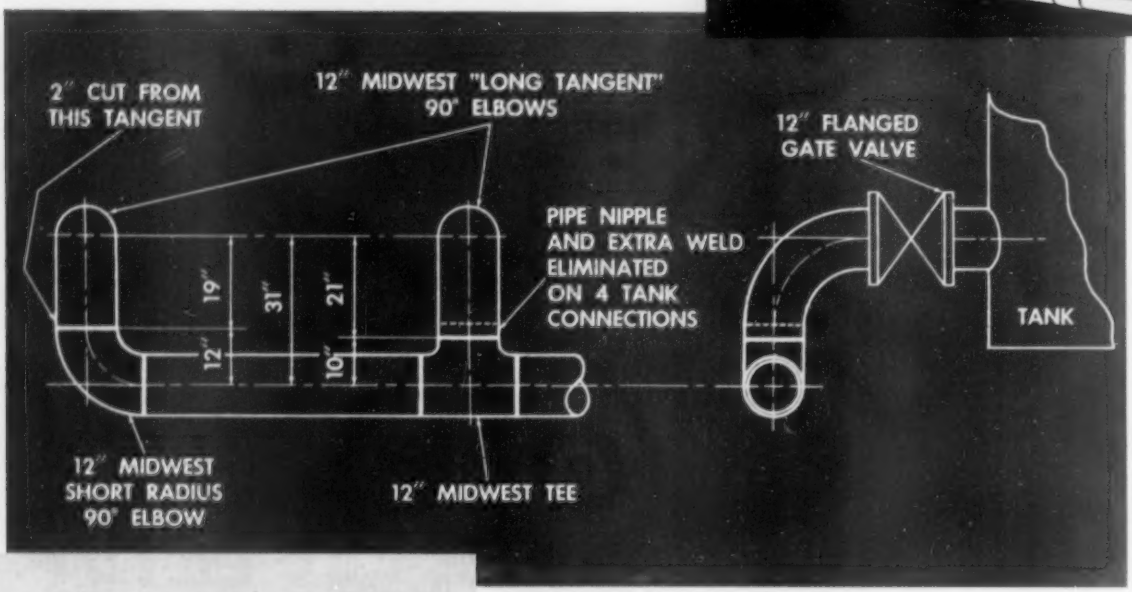
AT THE MODERN ELDORADO STATION in the Rancho Pipe-line System, G-E enclosed base-ventilated motors drive single-stage and two-stage pumps. Air ducts are located below floor level eliminating hazardous leaks from exposed pipe joints.

MIDWEST "LONG TANGENT" ELBOWS

SAVED $156.20

On This Welding Piping





MIDWEST "LONG TANGENT" ELBOWS COST NO MORE THAN OTHER ELBOWS

The Problem:

To connect the five tanks shown in the sketch at top to a common 12" header.

The Difficulty:

The center-to-outlet dimension of the 4—12" tees is only 10", while the shortest elbow available measures 12" center-to-end. Thus, if standard long radius elbows are used next to the five tank valves, four short nipples and four extra 12" welds would be required.

The Solution:

By using Midwest "Long Tangent" elbows as shown in the blueprint, the expense of the four extra nipples and welds was eliminated at the cost of just one cut! The actual net savings made by "Long Tangent" elbows on this job was $156.20.

Remember—Midwest "Long Tangent" elbows cost no more than regular elbows! For further information, write for Catalog 54.

MIDWEST PIPING COMPANY, INC.

Main Office, 1450 South Second St., St. Louis 4, Missouri

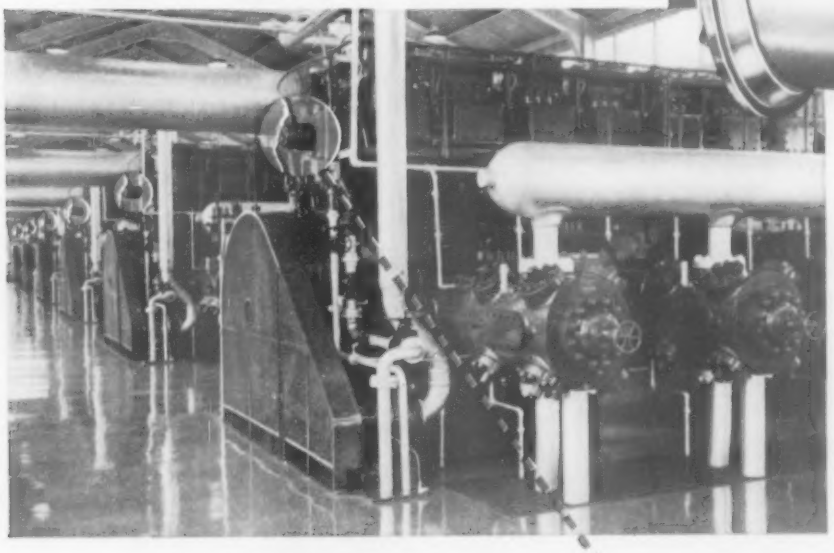
PLANTS: ST. LOUIS, PASSAIC, LOS ANGELES, and BOSTON

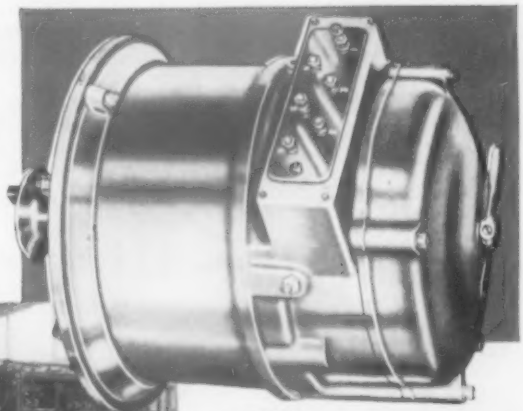
SALES OFFICES: NEW YORK 7—50 CHURCH ST. • LOS ANGELES 33—520 ANDERSON ST.
BOSTON 27—426 FIRST ST. • CHICAGO 3—79 WEST MONROE ST.
TULSA 3—224 WRIGHT BLDG. • HOUSTON 2—1213 CAPITOL AVE.
CLEVELAND 14—616 ST. CLAIR AVE.

6820

MIDWEST WELDING FITTINGS IMPROVE PIPING DESIGN AND REDUCE COSTS

SPECIFY THE AMERICAN BOSCH PULSE GENERATOR SYSTEM





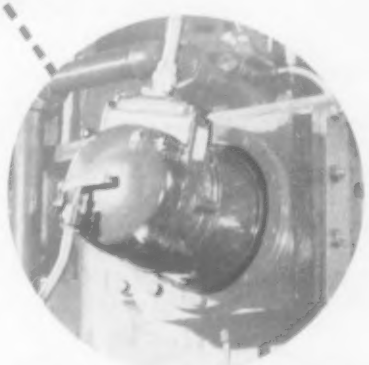
FOR TROUBLE-FREE IGNITION ON YOUR CONTINUOUS SERVICE GAS ENGINES!

The first American Bosch Pulse Generator installation at the Michigan-Wisconsin Pipe Line Co. plant, New Windsor, Ill., ran constantly for 23 trouble-free months before removal for inspection. Subsequently, 18 engines in the Michigan-Wisconsin plants were equipped with the Pulse Generator System.

Here is the ultramodern Ignition System that is now saving time, trouble and money for many Oil Industry gas engine users. The new American Bosch MGC Pulse Generator System cuts maintenance costs and downtime caused by ignition troubles, provides constant, trouble-free operation over long periods—as shown in the case of the Michigan-Wisconsin Pipe Line Company engines pictured above.

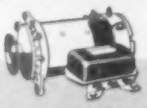
This new Ignition System generates precisely timed, low-voltage, high-current pulses. Passed through the primary winding of oil filled transformers at each cylinder, these pulses generate high voltage in the secondary winding, more than enough to provide reliable ignition for very high compression gas engines (from the current 250-400 psi to all presently contemplated engines of far greater compression pressures). Ignition cables carry only low tension current—no corona loss, no danger of fire or explosion. Only moving part is ball bearing mounted rotor—no contacts or distributor to cause condensation and corrosion problems. And the MGC's big capacity spells better ignition *all ways*.

You can have this greater capacity for long-term, trouble-free operation . . . Specify the American Bosch Pulse Generator System for all large stationary gas engines. American Bosch, Springfield 7, Massachusetts.



AMERICAN BOSCH

Automotive and Aviation Magnetos

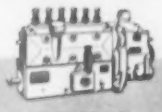


Generators and Regulators

Components for Aircraft Engines

Electric Wipers and Small Motors

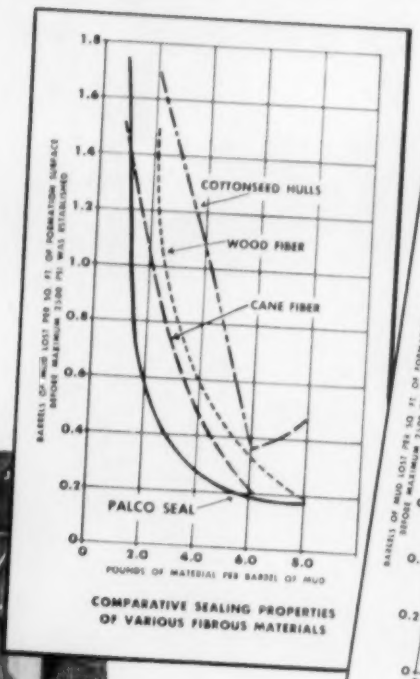
Ignition Coils

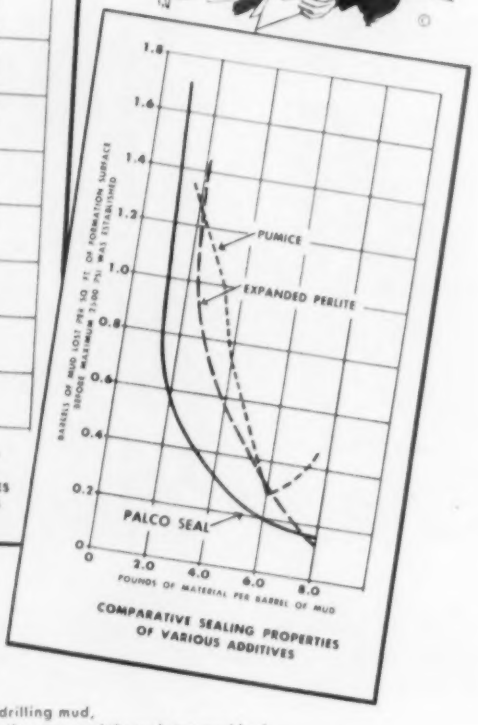


Diesel Fuel Injection Equipment

Comparative tests prove greater efficiency of Palco Seal

in preventing circulation mud losses





Correlating closely with field experience, graphs above show results of tests in which various amounts of circulation materials were added to drilling mud, circulated for 30 minutes, then pumped through a gravel bed of controlled density. The amount of mud loss before shute'f is plotted against pounds of lost circulation material used per barrel of mud.

Substantiated by field experience in thousands of actual drilling operations, the above graphs show how Palco Seal redwood fibers act more quickly and effectively to reduce circulation mud losses. Palco Seal's controlled combination of long and short fibers forms a dense matted barrier which becomes firmly embedded in the porous strata and fissures or cracks encountered during drilling operations. Complete unifrom sealing is assured by the fact that Palco Seal disperses thoroughly in mud and remains in suspension.

This ruggedly durable wood fiber possesses the inherent qualities of the enduring redwoods from which it is derived. Naturally resistant to rot and decay, Palco Seal affords maximum permanence in caulking thief formations. Palco Seal is now available in easy-to-handle loose-filled 40-lb. bags. It is also available in the popular 80-lb. compressed bales. For more effective prevention of loss of circulation in drilling operations, investigate Palco Seal, proved through a decade of field application.

Now available in loose-filled 40-lb. bags for easy handling. Also available in 80-lb. bales.

WRITE FOR BULLETIN No. 4-02 describing the properties, operating advantages, and composition of Palco Seal.

Available through oil field and mud service organizations. Inquiries from dealers invited.

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THE PACIFIC LUMBER COMPANY

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You will want full information on this important addition to the Autocar line. Fill in the coupon and find out what this engine can do to make your hauling more profitable—you'll be glad you did.

The mighty Mustang is also available for your replacement engine needs
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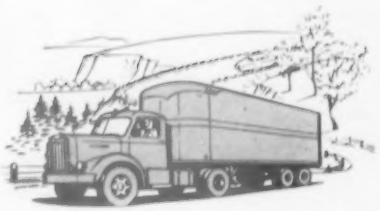
Autocars are sold and serviced throughout the world



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FITTINGS AND HOSE KITS

● Hose lines are the life lines of construction equipment. The breaking of a single fuel, air, water, or oil line while equipment is on the job results in expensive downtime until the damaged hose line can be replaced.

● This compact, new Aeroquip kit can be carried right on your field service truck. It contains a complete assortment of *SOCKETLESS* fittings and reels of Aeroquip 1525 hose that can be cut to required length.

● Hose line assembly is amazingly easy . . . and QUICK! No tools of any kind are needed because 1525 hose can be *pushed* on the *SOCKETLESS* fittings by hand. In spite of the ease of assembly the fittings STAY on.

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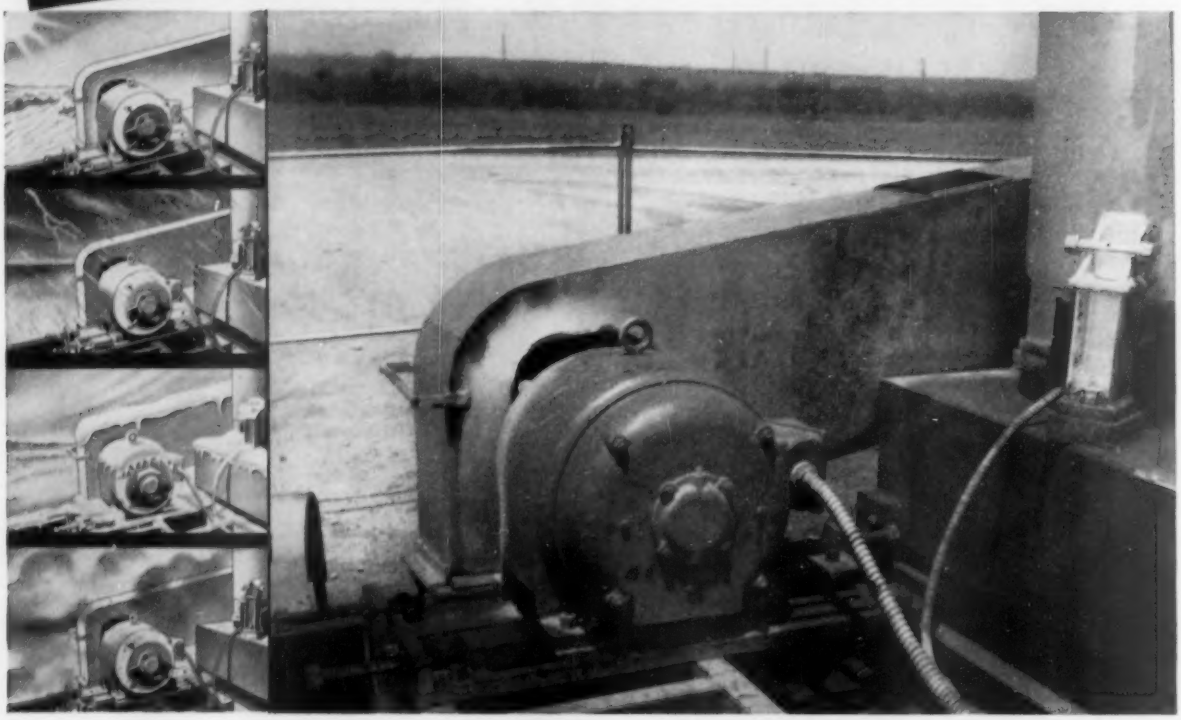

Wagner 25 hp splash-proof motor installed on a hydraulic long stroke pumping unit in Scurry County, Texas.

Oil well pumping rigs need motors with the stamina to stand up under continuous all-weather operation. They must operate dependably, without attention—under a blazing sun—in driving rain—in freezing weather—or in sand and dust storms.

The Wagner line of drip-proof 40° C motors, built for oil well pumping applications, are especially designed for continuous outdoor service. They are enclosed in cast-iron frames with double end ventilation. Baffles inside the endplates retard the entrance of water, yet direct a cooling flow of air around the stator iron and windings. The windings are specially treated for outdoor service and the conduit box is moisture-proof and dust tight. These motors are available in ratings through 75 hp and are built in three electrical types: normal torque and high torque, normal slip; and high torque, high slip.

In addition to these drip-proof motors, the Wagner line includes splash-proof motors for additional protection, if desired. For applications requiring single-phase motors, Wagner can furnish high power factor type capacitor start—capacitor run motors with the same enclosures. The line also includes totally-enclosed fan-cooled motors in standard or explosion proof types for use in pumping stations and refineries.

Write for Bulletin MU-137 on Oil Well Pumping Motors and Bulletin MU-132 on Totally-Enclosed Cast Iron Motors. Thirty-two branch offices are ready to assist you in any motor application problem.

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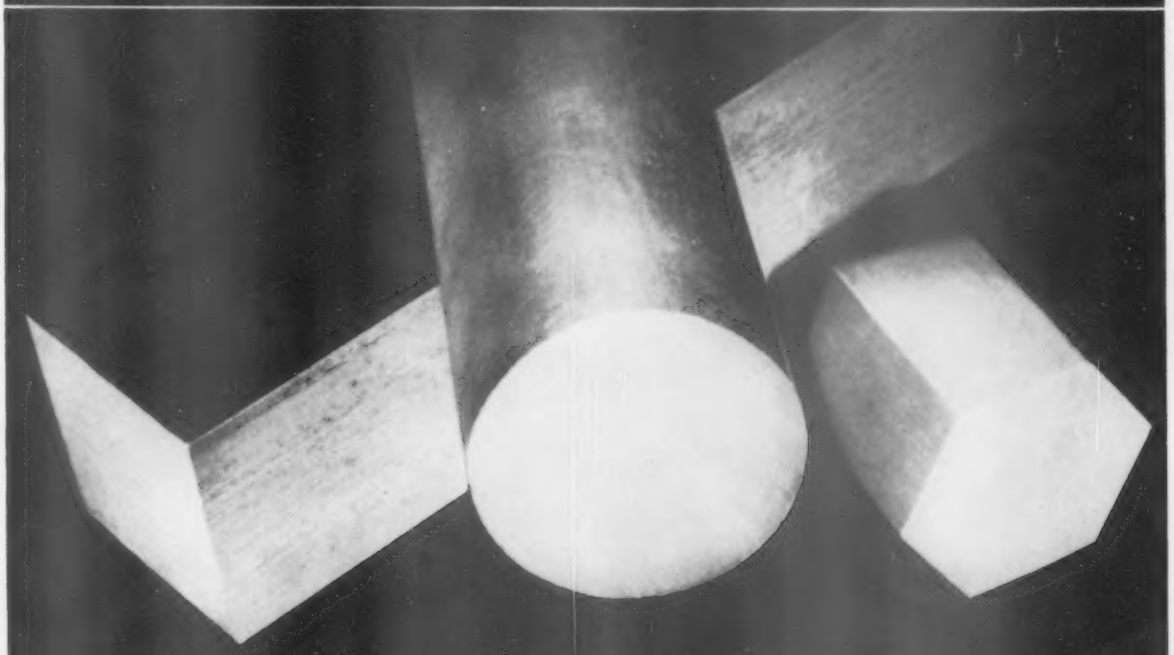

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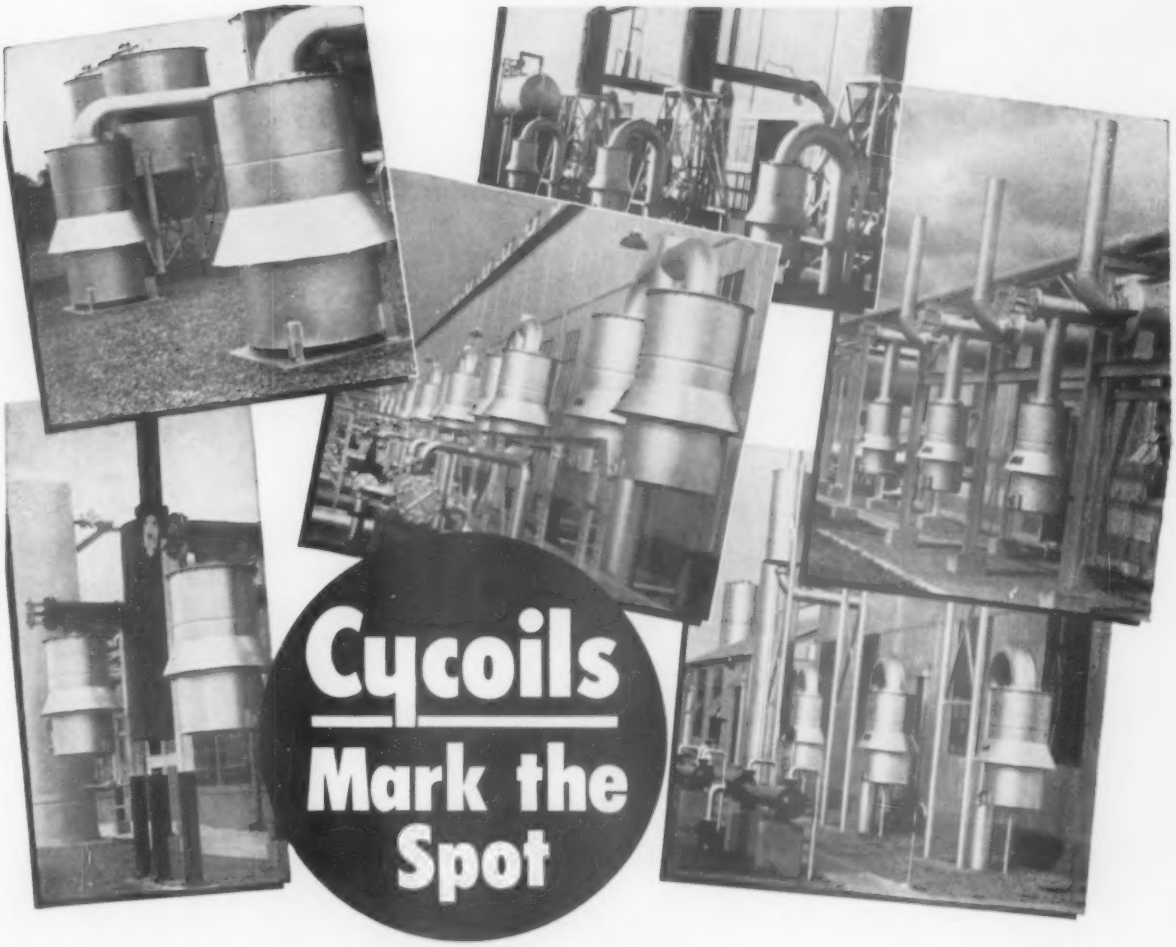

Where Engines and Compressors Enjoy Complete Dust Protection

Such spots are numbered by the hundreds. Nor are all of them confined to the "dust bowl" areas of the nation. Find a cost-minded management that recognizes how dust damage contributes to engine down-time and repairs and you'll find dependable Cycoil Oil Bath Air Cleaners on the job.

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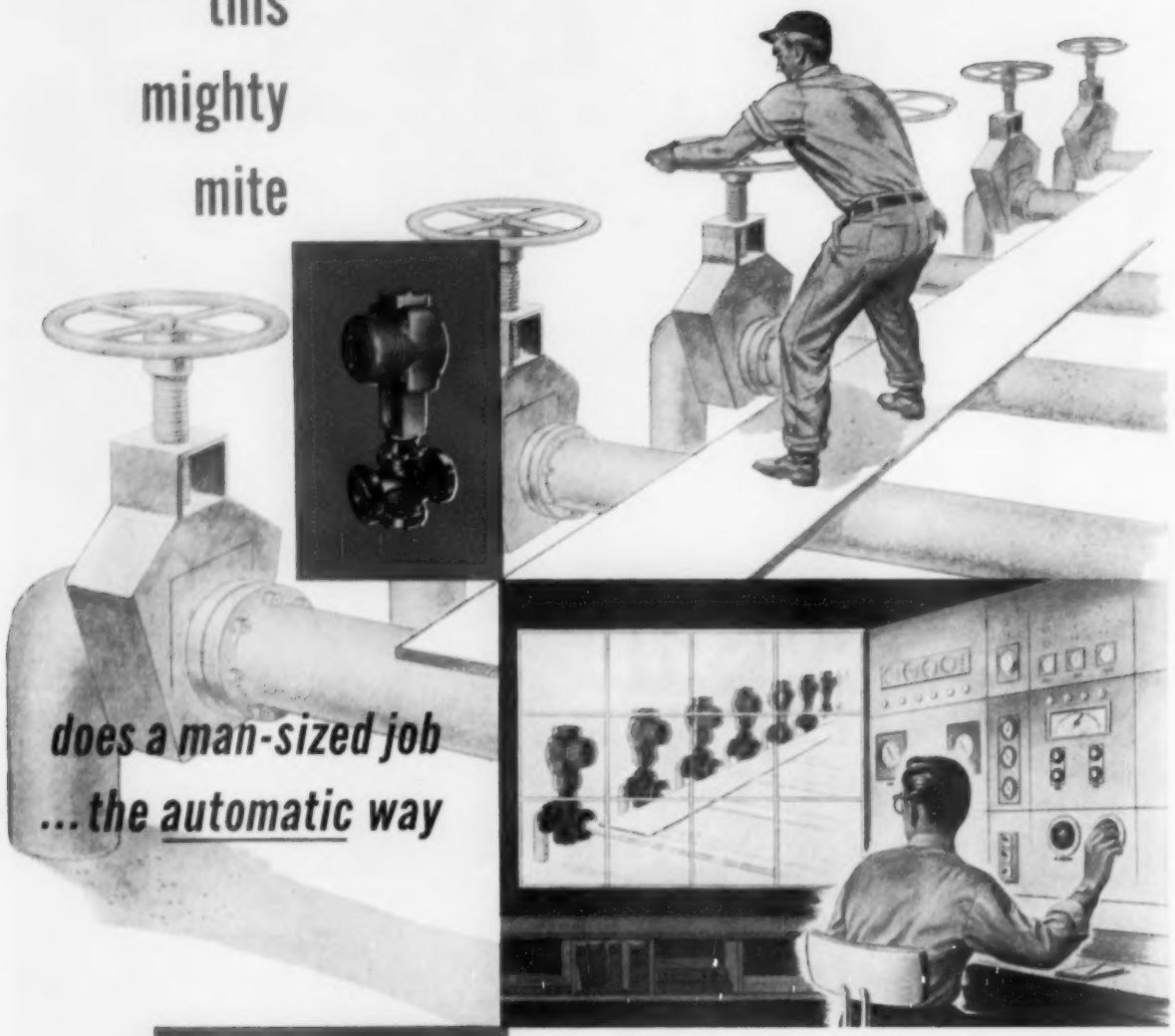

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Don't give danger "spots" a chance to wreck you! Give them the kind of coverage shown in the demonstration above. Here, a gasoline-filled pit was set on fire — and extinguished in a matter of seconds by a Rockwood *Spot Protection System* discharging Rockwood FogFOAM. This FogFOAM also provided fire protection to the surrounding area by covering the edges of the pit.

Rockwood FogFOAM is formed by mixing 3 parts Rockwood Double Strength FOAM with 97 parts water — then discharging it through specially engineered FogFOAM heads or nozzles. A protein type liquid, it is used in spot protection systems and also in fire hose lines by being discharged through the Rockwood Type SG-60 Nozzle or Type FFF Nozzle. The Type SG-60 Nozzle discharges high velocity FogFOAM, solid FOAM stream (through an Extension FOAM Shaper) and, when FOAM is shut off, high velocity WaterFOG, low velocity WaterFOG or straight water stream. For ¾", 1" and 1½" fire hose lines.

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Rockwood Double Strength Foam clings to metal surfaces as an insulator, flows freely at sub-zero temperatures. Excellent for extinguishing fires in gasoline, benzol and other highly volatile flammable liquids as well as ordinary combustibles.

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Nash Compressors produce 75 lbs pressure in a single stage, with capacities to 6 million cu. ft. per day in a single structure. Since compression is secured by an entirely different principle, gas pumping problems difficult with ordinary pumps are often handled easily in a Nash.

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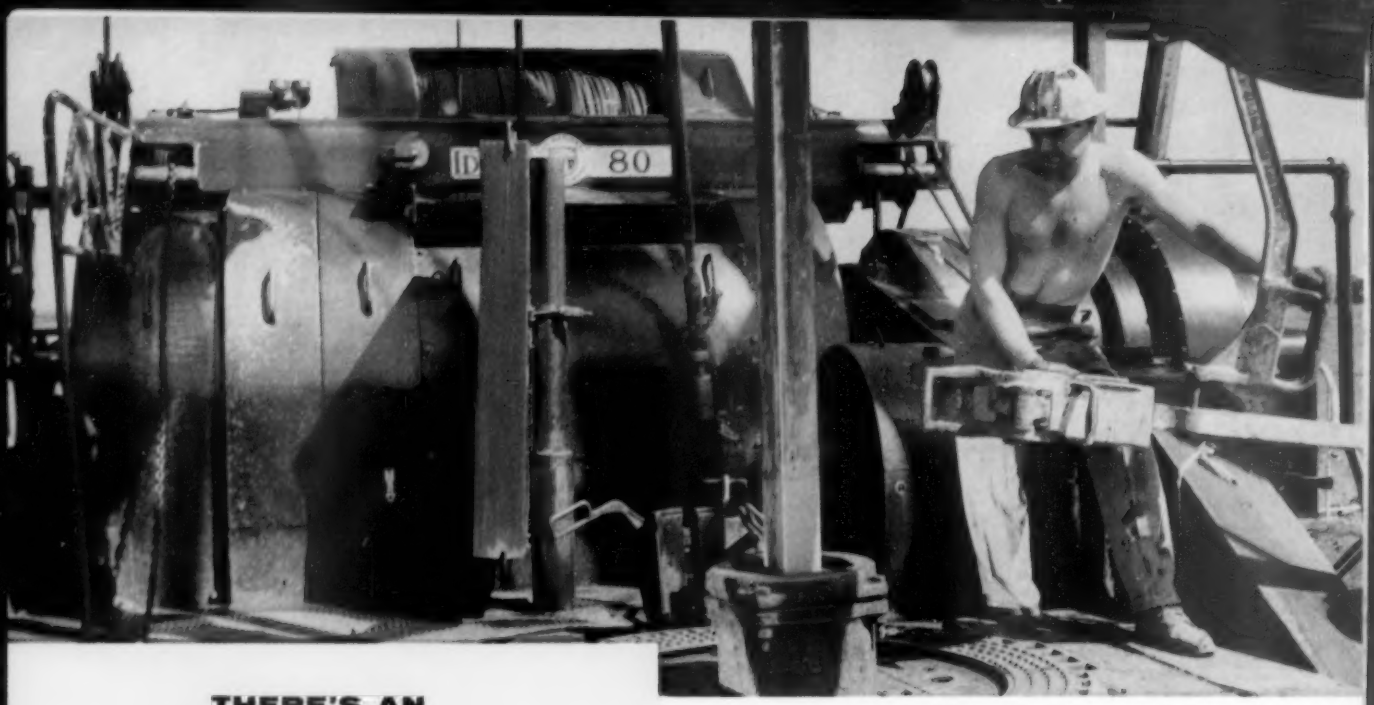

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Need a rig that's easy to operate and long-lasting? You can choose the one that's best suited for your requirements from the complete line of 10 Ideal Rigs for every drilling job.

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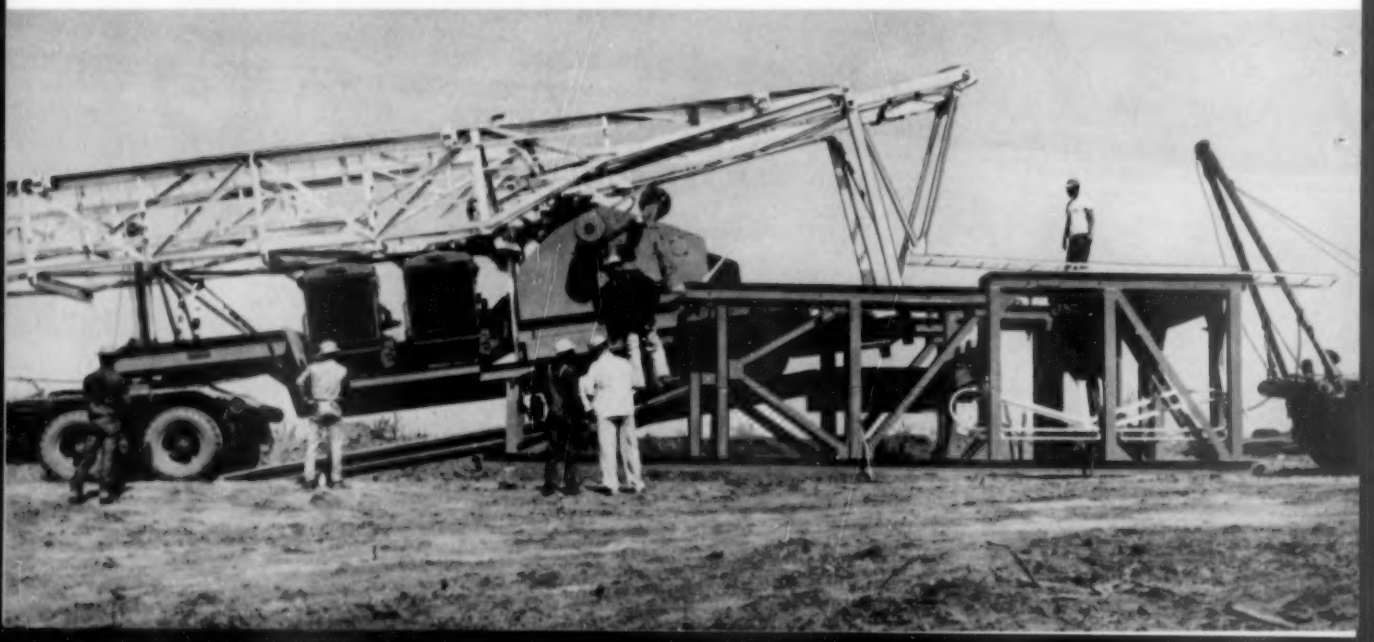

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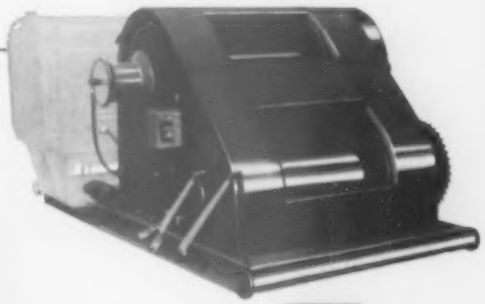
Type	T-8	T-12	T-20	T-32	50-A	55	80-B	110	130	160
Horsepower Rating	80	120	200	320	450	550	800	1100	1300	2000



TYPE **T-8:**

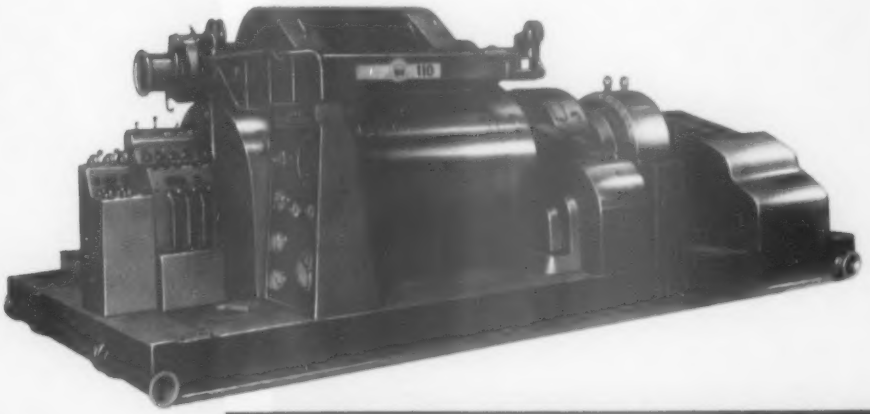
National's smallest portable rig, with a servicing and workover depth of 2,000′ to 4,000′.

TYPE **55:**

Rated nominally at 550 input horsepower, the Type 55 is a medium depth rig designed for use with torque converter equipped engines.

TYPE **110:**

Of sectionalized design the Type 110 is rated at 1100 horsepower.



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see the rig drives designed for top efficiency ... on the next page

...and to make the most of your power, specify **IDEAL®**

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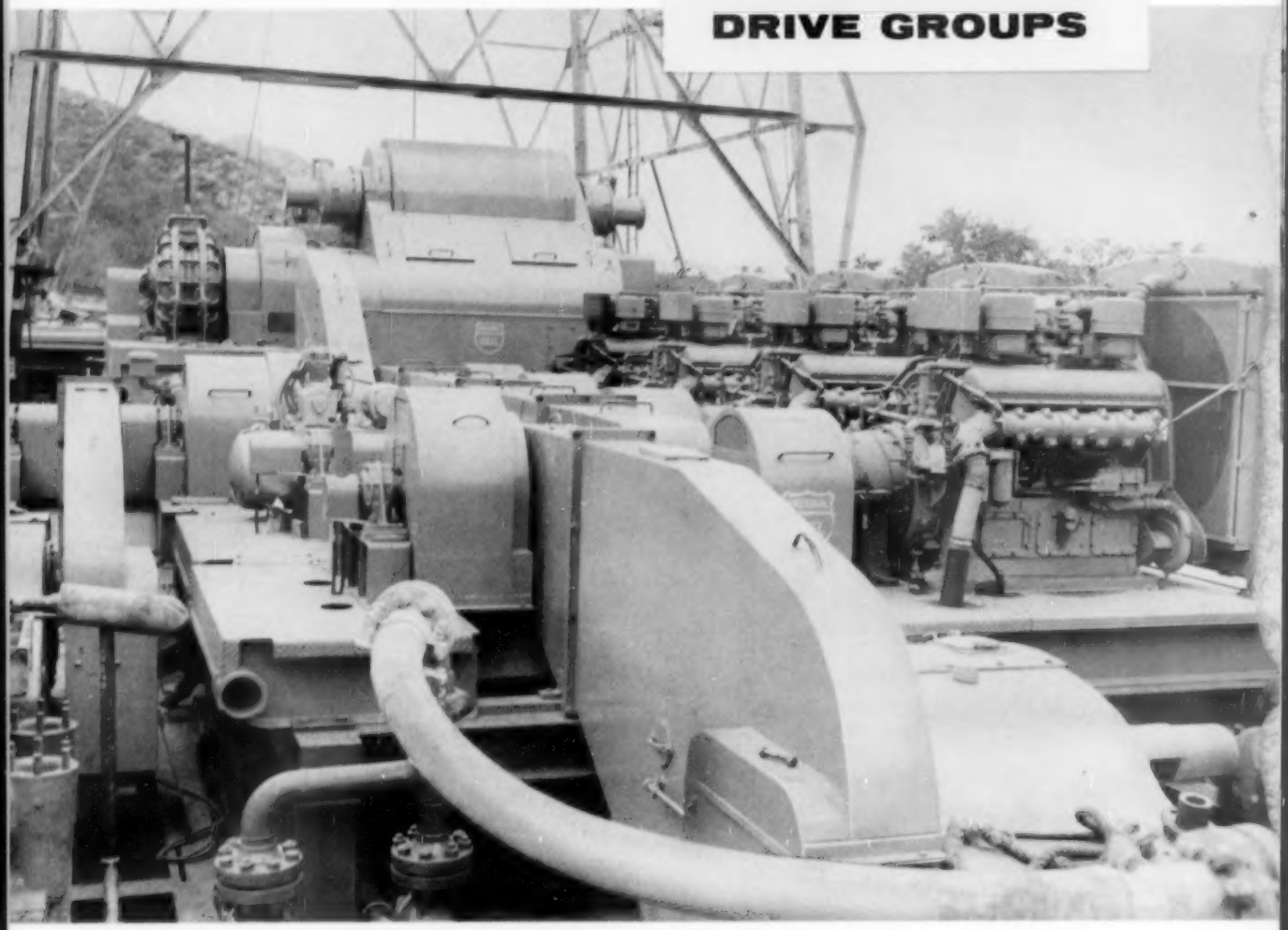

Ruggedly built, compact, easy to transport and rig-up, Ideal Drive Groups provide dependable power transmission under all drilling conditions. In designing and building Ideal Drive Groups for modern field requirements, National Supply has developed an exceptionally wide range of flexible power equipment for long, economical service.

You'll find it worthwhile to get complete details on these outstanding features of Ideal Drive Groups—

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Slush pump drives, both independent and integral types, for every fluid requirement.

Three types of transmissions—a choice of mechanical, Ideal Gyrol, or National Torque Converter.

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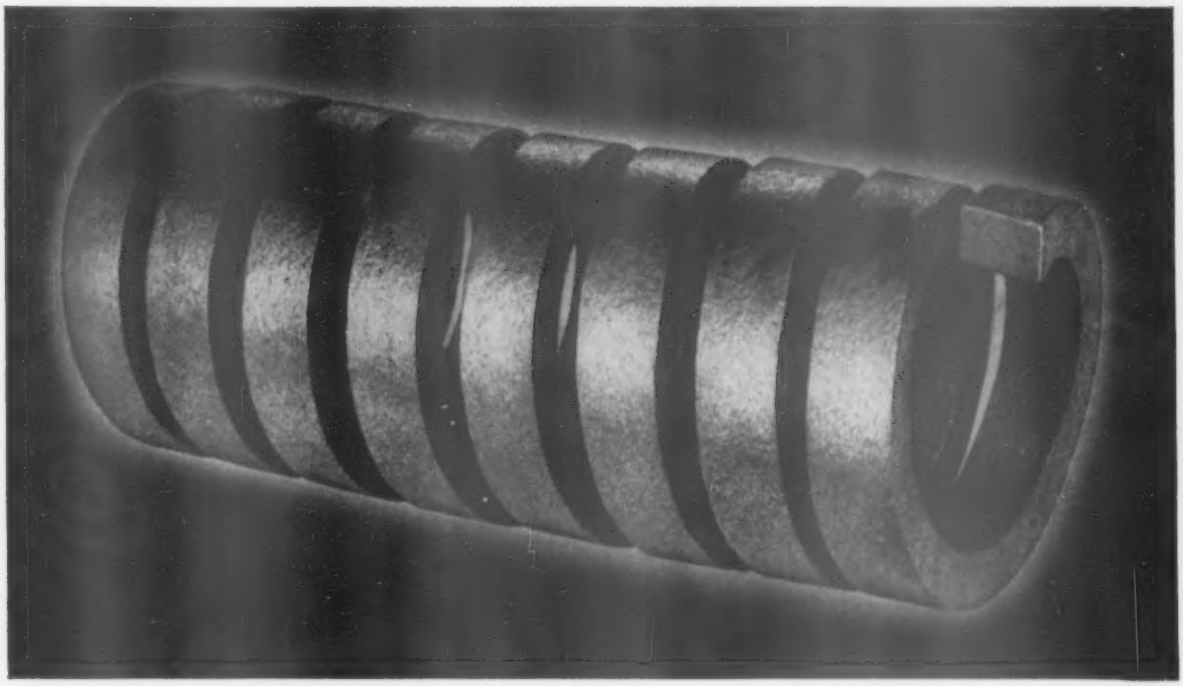
For sealing oil and solvent pumps you can not beat R/M "versi-pak"®



R/M "versi-pak"—known by number as R/M 1845—is engineered so precisely to your oil and solvent pump requirements that it permits you to practice preventive rather than corrective maintenance. Its lubricants, ground in during manufacture, are so securely locked within the compound that even after wear sets in, the effectiveness of the bearing surface remains unchanged. An unusually uniform dispersion of long asbestos fibers throughout the binder gives it a completely homogeneous construction and, therefore, tremendous stability under pressure. And because no organic materials are included—only the cleanest, softest, most open asbestos fibers obtainable—it has exceptionally high resistance to heat.

R/M "versi-pak" is recommended for all centrifugal oil and solvent pumps operating at a maximum of 350° F and 600 psi. With it you can count on fewer adjustments, less downtime, lower maintenance costs, and longer equipment life. For complete information, write today.

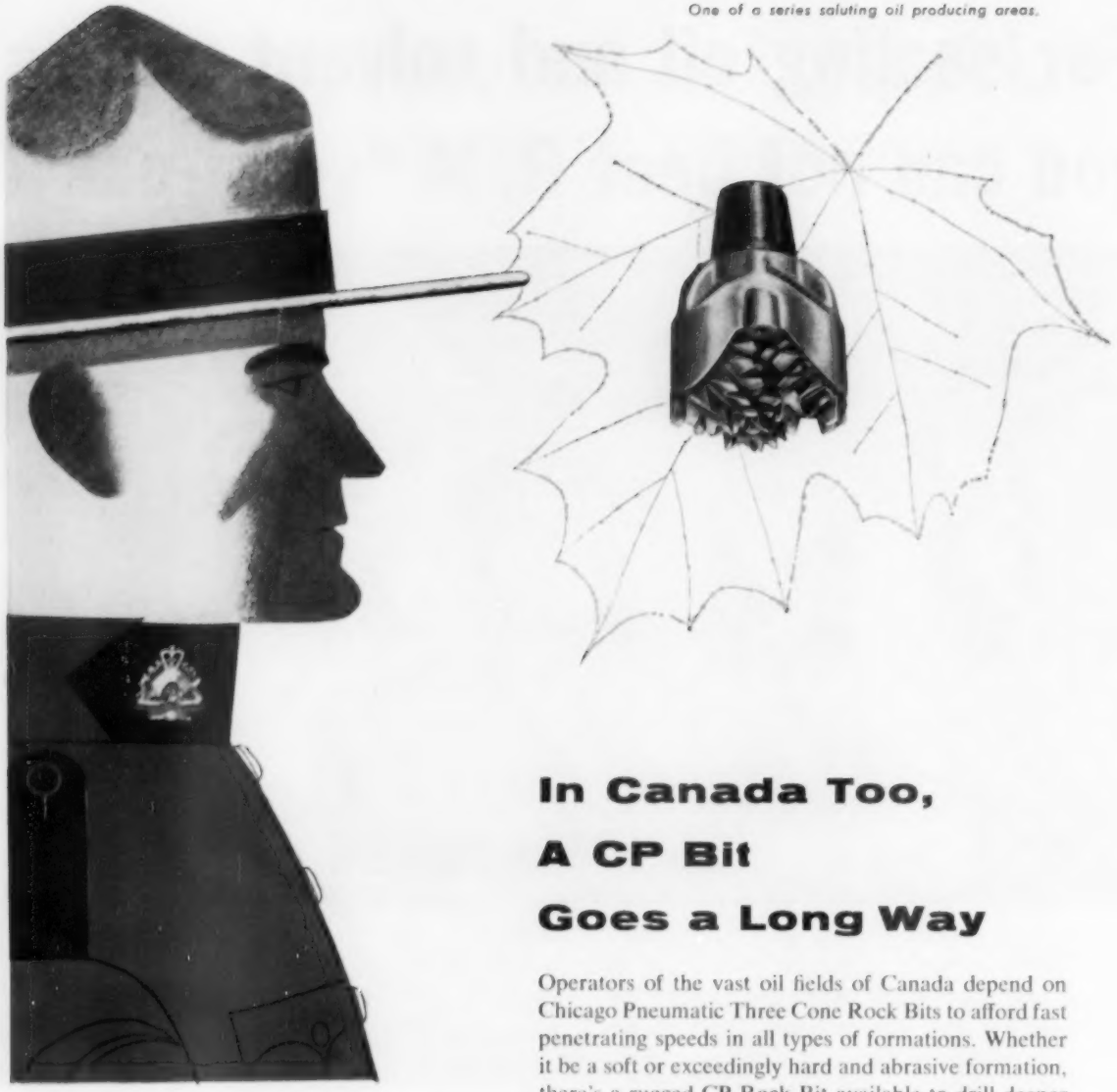
R/M MAKES A COMPLETE LINE OF PACKINGS AND GASKETS—AVAILABLE FROM YOUR R/M DISTRIBUTOR

R/M PACKINGS
RAYBESTOS-MANHATTAN, INC.
PACKING DIVISION, MANHEIM, PA.

FACTORIES: Bridgeport, Conn.; Manheim, Pa.; No. Charleston, S.C.; Passaic, N.J.; Neenah, Wis.; Crawfordsville, Ind.; Peterborough, Ontario, Canada

RAYBESTOS-MANHATTAN, INC., Packings • Asbestos Textiles • Industrial Rubber, Engineered Plastic, and Sintered Metal Products • Abrasive and Diamond Wheels • Rubber Covered Equipment • Brake Linings • Brake Blocks • Clutch Facings • Fan Belts • Radiator Hose • Bowling Balls

One of a series saluting oil producing areas.



In Canada Too, A CP Bit Goes a Long Way

Operators of the vast oil fields of Canada depend on Chicago Pneumatic Three Cone Rock Bits to afford fast penetrating speeds in all types of formations. Whether it be a soft or exceedingly hard and abrasive formation, there's a rugged CP Rock Bit available to drill deeper and faster with every twist of the drill stem. For information on the seven different types of CP Three Cone Rock Bits write, Oil Tool Division, Chicago Pneumatic Tool Company, 5000 U. S. Highway 81 South, Fort Worth, Texas.

Chicago Pneumatic

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FORD "134"
4-Cylinder
Engine Assembly
134 cu. in. displ.

FORD "172"
4-Cylinder
Engine Assembly
172 cu. in. displ.

FORD "223"
6-Cylinder
Engine Assembly
223 cu. in. displ.

FORD "239"
V-8 Cylinder
Engine Assembly
239 cu. in. displ.

FORD "256"
V-8 Cylinder
Engine Assembly
256 cu. in. displ.

FORD "317"
V-8 Cylinder
Engine Assembly
317 cu. in. displ.

Only FORD offers a complete line of ultra-modern HEAVY DUTY INDUSTRIAL ENGINES at Low Ford Prices!

Here's a Choice of Six Large Bore, Short-Stroke, Low Piston Speed Engines . . . All of the Latest Overhead-Valve Type for Top Economy, and Longer Life.

Tests have proven conclusively that, in their respective displacements, these low-friction Ford engines deliver *more* usable power on *less* fuel. Also, short piston travel reduces wear, so that engines last longer. And remember, too, that parts and service are available through Ford Dealers everywhere.

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YOUR JOB IS WELL-POWERED WHEN IT'S FORD-POWERED

Closed Type Power Unit
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Typical Closed Power Unit
for 6-cyl. and 8-cyl. Engines

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REPUBLIC MAKES

24-page picture booklet takes you on quick trip through Republic's new seamless mill. Ask for No. ADV 595.

Republic Casing and Tubing make up quickly. Straight lengths together with uniform roundness mean quick, easy stabbing. Clean, accurate threads spin in and tong up fast. And uniform depth of steel under thread roots guards against pullouts—gives full protection in the hole. To save time and money, specify Republic.

or Shallow Wells

BOTH ELECTRIC WELD and SEAMLESS CASING and TUBING

Specifically, what does this mean to you in the oil business?

It means that when you purchase Republic Electric Weld or Seamless Casing and Tubing you're assured of the same high quality throughout the string—quality that has earned an outstanding reputation in the oil industry throughout the world. The reason is clear. Oil producers know they're protected by Republic's rigid quality controls—that Republic strings are dependable, economical.

Republic's Normalized Electric Weld Casing and Tubing, widely used in every field for the past 25 years, are available in grades H-40 and J-55. Sizes range from 2⅜" through 13⅜" O.D.

LOWER AWAY

Republic Seamless Casing and Tubing, newest additions to the line, are second to none in the industry. They're produced at the world's most modern seamless mill, employing the latest precision equipment and techniques—made in grades J-55 and N-80. Sizes range from 2⅜" through 9⅝" O.D. For complete information, call your nearest Republic Pipe Distributor. Or write to:

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GENERAL OFFICES • CLEVELAND 1, OHIO
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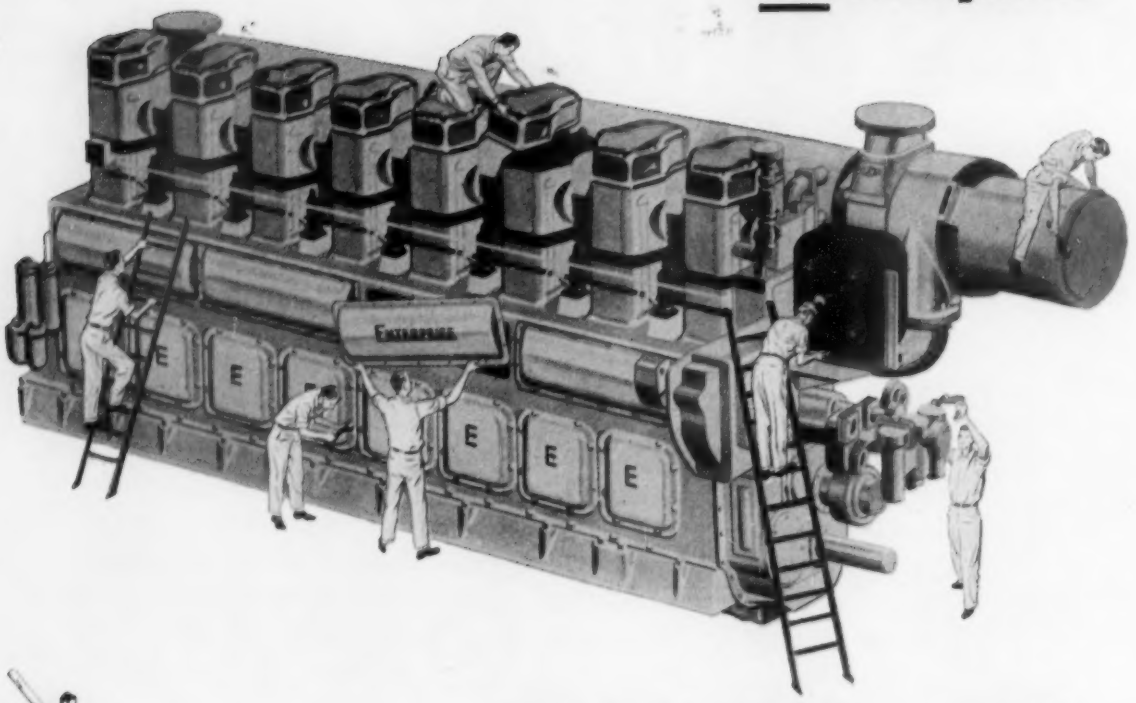
REPUBLIC STEEL

REPUBLIC CASING AND TUBING
Electric Weld and Seamless

Other Republic Products include Line Pipe—Steel and Plastic Pipe—Carbon, Alloy and Stainless Steels—Studs, Bolts and Nuts—Heat Exchanger Tubes

It's easy to get to all the parts



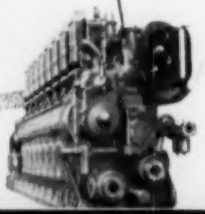
Check these points on "Easy-Access" ENTERPRISE Design

All major moving parts are enclosed with removable covers:

- ✓ Main and connecting rod bearings are fully accessible through large door plates on both sides.
- ✓ Cams, followers, camshafts and bearings are easily reached and removed.
- ✓ Cylinder head and rocker arm assemblies, push rods and fuel nozzles are easy to reach by removing oil and dust-proof covers.
- ✓ Gears are accessible through easily removable inspection covers.

No bulky shrouds or surplus covers to remove before getting to engine.

Parts, accessories and controls requiring occasional inspection or servicing are externally mounted.



You'll find that ENTERPRISE accessibility saves time, money and manpower in maintenance and overhaul

Ever watch precious hours slip by trying to find a way to dismantle, inspect or replace an engine part or assembly? Such unnecessary and costly down-time is something you don't have to worry about with modern, "easy-access" ENTERPRISE Diesels. For ENTERPRISE service-wise engineers have designed every model in the entire 73 to 2284 HP line for maximum accessibility and easy, low-cost servicing. That's why we say – and mean – you'll have less down-time if it's powered by an ENTERPRISE Dependable Diesel!

Write for descriptive bulletins, or call your nearest ENTERPRISE *Diesel sales office.*

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DEPENDABLE
Engines

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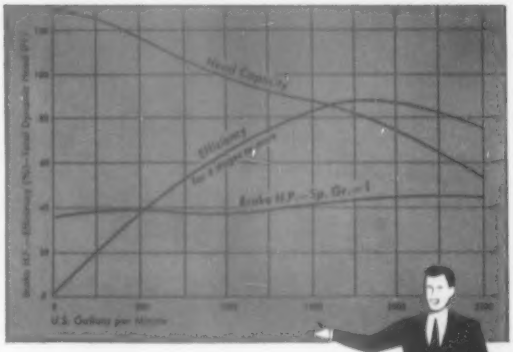
DIESEL ENGINES • OIL BURNERS • PROCESS MACHINERY

Through Research... A Better Pump!

Research facilities, unparalleled in the industry, are operated by A. O. Smith. These facilities are supplemented by special assignments in laboratories of great universities. This research goes beyond laboratories and enters our customers' offices and operating plants. In fact, you may be one of the many engineers or operators who told us of your requirements which resulted in this new type of pump which excels previous standards of performance and useful life. This combination of research plus experience has produced pumps with higher efficiency, lower operating cost, longer life. Each is "Job Engineered" to suit your specific requirements.

Through research ...*a better way*



CHARACTERISTIC CURVES

These curves show just how successfully SMITHway "Job Engineered" Pumps meet your needs. Graph covers an actual test on a 14" SMITHway DKH Pump, 1760 rpm., with glass-lined bowls and bronze impellers; capacity 1875 gpm.; head per stage; 79 feet; efficiency (4 stages): 87%.

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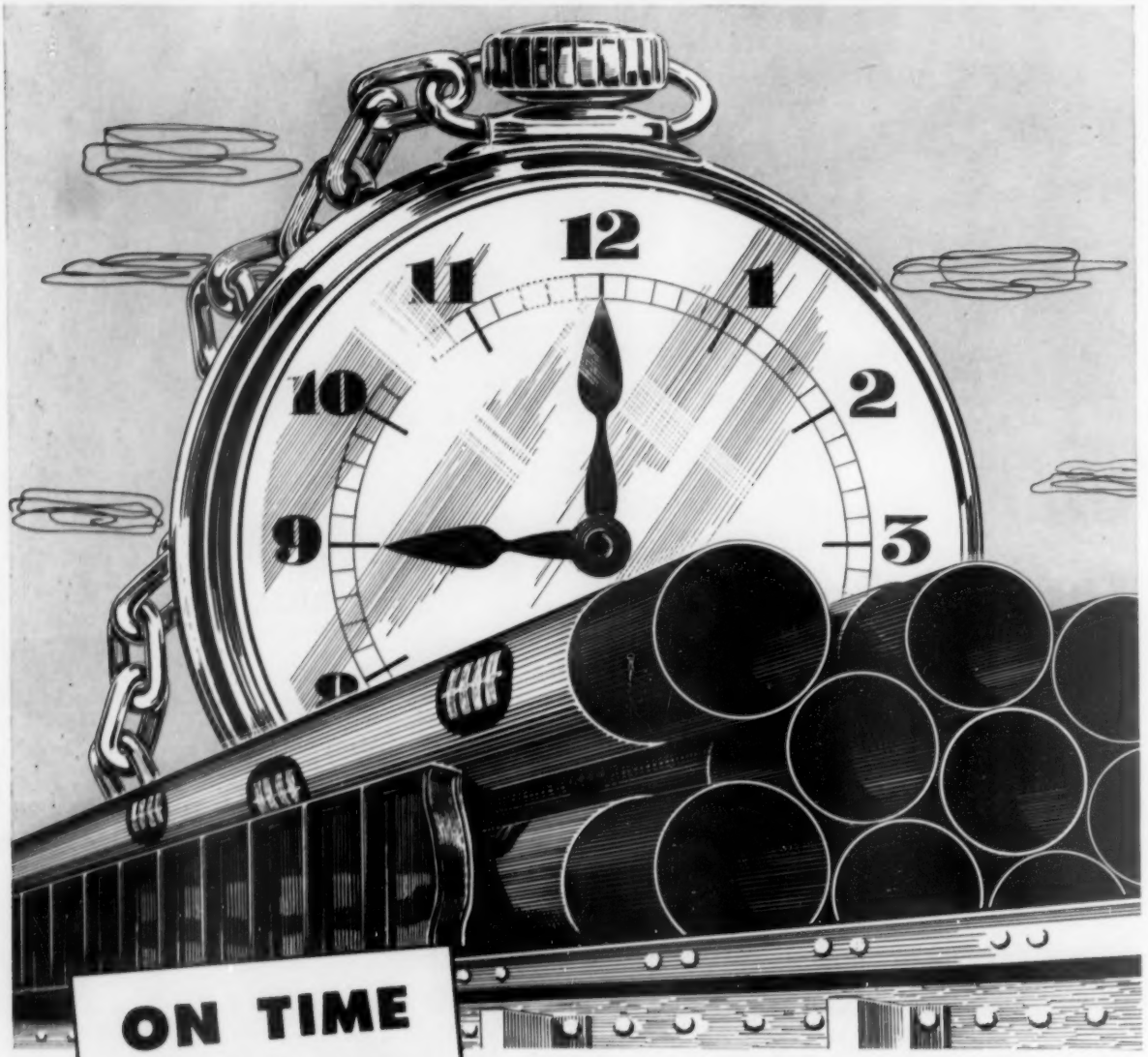

ON TIME SERVICE

Another of HILL, HUBBELL's "Things That Money Can't Buy"

No matter how efficiently pipe is protected, Hill, Hubbell—pioneers in the business—know that it must be *in the right place at the right time* for profitable results. That's why correct *timing* and Hill, Hubbell have become synonymous!

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Factory Applicators of Pipe Coatings and Wrappings

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NEW!

SPOT WELD without jigs or back-up plates

Now you can spot weld with complete maneuverability — and as fast as you can pull the trigger — with the new portable AIRCOSPOT® Gun.

With **AIRCOSPOT,** Air Reduction's new inert-gas-shielded spot welding unit, you simply touch the water-cooled gun to one side of the work and pull the trigger. In about a second you have a spot weld. It will be a good one, too, because **AIRCOSPOT'S** inert gas shield completely protects the hot metal from contamination by the air.

Write today for prices and folder that provides detailed information.

AIRCOSPOT welds all sheet steels — including stainless up to 3/32"—to bottom sections of varying thickness.

AIRCOSPOT is fast. Once the controls are set, you can make thirty or more welds a minute.

AIRCOSPOT is easy to use. Operators need no special training. The welding cycle is fully automatic.

AIRCOSPOT is handy. Gun weighs four pounds, is nine inches long. All connections — current, gas and water—are through a single control panel.

AIRCOSPOT is rugged. No abuse-sensitive high frequency or electronic circuits, because Gun is of electromechanical design.

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Typical BS&B COLD-FRAC* System With Hydrate Inhibitor in service on gas condensate well production.

LOW TEMPERATURE BS&B SEPARATION

COLD-FRAC* SYSTEM

Which Type Is The Right One For YOUR Conditions?

Wherever there is the problem of separating natural gas from its condensable fractions at low temperatures . . . and of stabilizing or fractionating the recovered condensate to specification product . . . there is a correct type of BS&B COLD-FRAC System to do the job! Any combination of conditions can be handled efficiently by one of these units:*

3 Types For Gas Condensate Well Production!

1 COLD-FRAC* System Without Hydrate Inhibitor. After free water is removed, high pressure gas is expanded into a special separator where hydrates are formed and melted. This system is necessarily limited to operation above the hydrate-formation temperature up to the point of expansion, and can therefore be used only where high pressure drops are available.

2 COLD-FRAC* System With Hydrate Inhibitor. Allows the use of regenerative heat exchange, making it applicable to a wider variety of situations because less expansion is required to achieve maximum recovery.

3 COLD-FRAC* System With Hydrate Inhibitor And Mechanical Refrigeration. Where declining wellhead pressures have limited the separator temperatures to the point where maximum recovery cannot be realized, mechanical refrigeration is added to supplement available natural refrigeration.

2 Types For Lease-Located Gasoline Plants!

1 COLD-FRAC* System With Hydrate Inhibitor And Natural Refrigeration. Applicable to high pressure, high gas-oil ratio oil wells. Uses the same principle of expansion refrigeration that is applied to gas condensate well production. Condensables are fractionated to produce specification natural gasoline and LPG products.

2 COLD-FRAC* System With Hydrate Inhibitor and Mechanical Refrigeration. Used for processing the casing-head gas that is separated from low pressure oil well production. Mechanical refrigeration is used to reduce temperatures to a point where condensables can be separated.

* "COLD-FRAC" is a trade-mark of Black, Sivalls & Bryson, Inc. (Patented and patents applied for)

The name to remember in Low Temperature Separation is — COLD-FRAC! By BS&B.*

EFFICIENCY OVER 60 YEARS BS&B RELIABILITY

BLACK, SIVALLS & BRYSON, INC.

West Coast Sales and Service Division, Dept. 1-A11A

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No. 3 J. Timken.. ready for the big frac

and a Loan From the FIRST Closed the Deal

put FIRST financing in your own oil future

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NATIONAL BANK in Dallas

MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

We tie truck axles in

in the new Timken-Detroit indoor proving ground

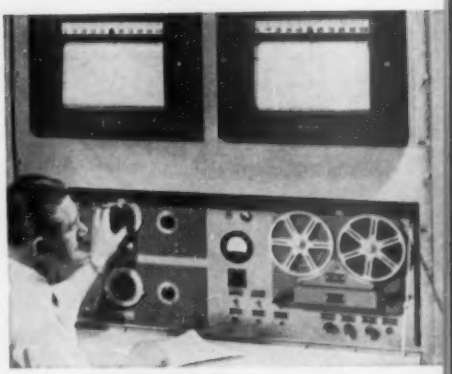
. . . and only Timken has it!

We smash, twist, jerk and over-load them. Match every imaginable hauling situation. Then add a few ruinous tricks of our own.

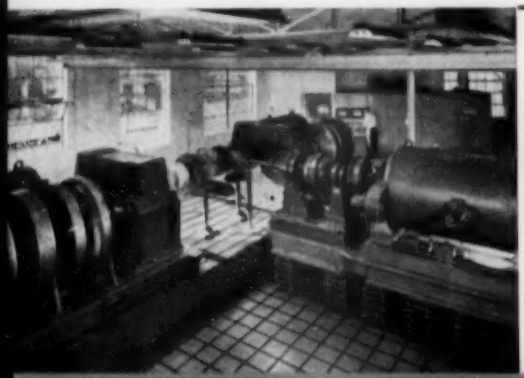
It's done on purpose. So we can tell you in advance that a Timken-Detroit axle can take a more brutal beating on the job it was designed for than any other axle made.

To prove it, we condensed a multi-thousand acre proving ground into one room. In it, our engineers can apply 50 years of experience in building axles for trucks, buses and trailers. Here axles and gearing are subjected *indoors* to any possible *outdoor* hauling condition. Axle performance is measured and analyzed under absolute scientific control!

As a result: you enjoy longer axle life; less maintenance, repairs and down-time; lower operating costs; fatter profits. No wonder Timken-Detroit axles are the choice of manufacturers and owners everywhere!

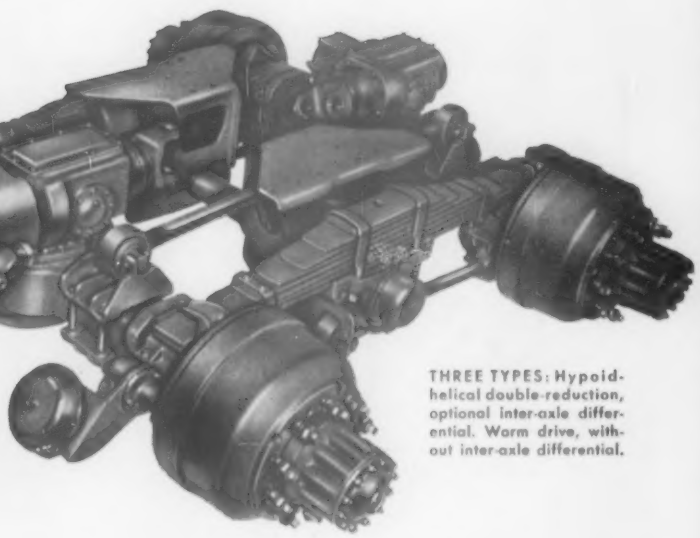


This is our "truck driver." He works in our "Torture Chamber." Above him are graphs showing speed and torque performance under any operating condition he chooses . . . soft ground at full load . . . mountains . . . express highways or side roads. With special dials, recorders and electronic devices, he actually *drives* the axle with scientific accuracy from his chair!



How TDA proves axle quality in this "Torture Chamber"

We pick one of our axles at random . . . then duplicate a hauling condition, hour after hour, day after day . . . simulating half a million miles of the toughest driving situations in just a few days. Or "invent" a test like going uphill with a full load from California to New York non-stop. There is no other axle testing like it in the world!



THREE TYPES: Hypoid-helical double-reduction, optional inter-axle differential. Worm drive, without inter-axle differential.

Hauling pipe? You need Timken-Detroit axles—duplicates of axles given the "works" in our indoor testing ground. Simulating punishment the axle gets hitting a chuck hole with capacity load every 4 seconds, 24 hours a day, month after month—to save *you* money on maintenance and repairs and make *you* more money every load.

knots

TIMKEN *Detroit* **AXLES**

TIMKEN DETROIT AXLE DIVISION
ROCKWELL SPRING AND AXLE COMPANY
DETROIT 32, MICHIGAN

The Accepted Standard — TDA CO

TRADE MARK REGISTERED

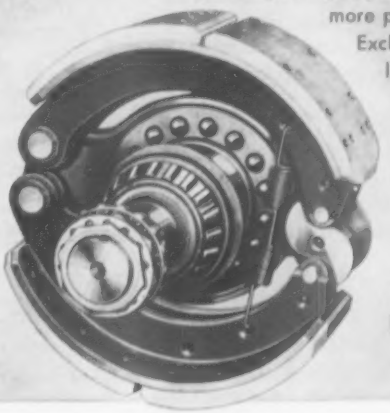
"TORTURE-TESTED"
to Save Money on the Job

WORLD'S LARGEST MANUFACTURERS OF AXLES FOR TRUCKS, BUSES AND TRAILERS

For six-wheeler operation . . . the TDA Tandem Drive Rear Axle Unit

Now—the *world's finest* tandem drive rear axle unit for heavy-duty motor trucks! And with these features, developed, introduced and pioneered by TDA: (1) Available in 3 types of final drives and 3 capacities. (2) Top-mounted straight-line final drive eliminates propeller shaft angularity. (3) Optional inter-axle differential . . . spur gear design, cab-controlled power-lockout. (4) Torsion flow axle shafts . . . guaranteed for 100,000 miles or three years, whichever occurs first. (5) Hot forged steel axle housing . . . guaranteed for the life of the vehicle. (6) Unit-mounted "P" series power brakes . . . for longer life, greater economy and efficiency. (7) Cradle ride spring suspension and paralleled torque rod system . . . maintain correct alignment and weight distribution regardless of driving and braking conditions. (8) Exclusive two-piece trunnion tube bracket speeds servicing. (9) Removable torque rod and spring guide brackets . . . for positive alignment, easier replacement. (10) Rubber torque rod bushings and rubber spring seat bushings . . . eliminate metal-to-metal contact. Require no lubrication.

New TDA brake shoes save up to 40 lbs. per axle



• Lightweight, pressed steel construction to give you more payload plus long wear and safety. Exclusive ¾" TDA "Econoliner" brake liners held rigidly by 12 deep-set rivets per block—*not bolts*. Liners are thickest at center where greatest wear occurs—taper down at ends. Result—longer wear, greater stopping ability. New cam roller mountings never seize or brinnel. Light nylon camshaft bearings wear up to 4 times as long! It's America's new brake shoe!

Plants at: Detroit, Michigan • Oshkosh, Wisconsin • Utica, New York • Ashtabula, Kenton and Newark, Ohio • New Castle, Pennsylvania

WHEN CREEP STRENGTH IS THE FIRST FACTOR

Tube Selection Cannot be Reduced to a Formula — *even a complicated one*

Tubing in service at elevated temperatures will continually deform with time when subjected to stresses considerably below the yield strength of the material. This continued deformation of a material with time due to an applied load, and which eventually leads to fracture, is defined as creep. The ability of tubing to resist creep at elevated temperatures is affected by a variety of factors. Consequently, in the selection of the optimum tubing for a specific application, such variables as composition, melting practice and heat treatment must be considered since these factors in turn influence the creep strength of metals and alloys.

To aid you in the selection of the most suitable tubing, B&W has conducted, and is continuing to conduct creep tests on the numerous B&W Croloys, the results of which can contribute substantially to the proper choice for your particular application. These tests may be considered as actual working tests since commercial materials, in various conditions of heat treatment, are tested at temperatures which may range between 800 and 1800 F. Such creep tests are usually run for a minimum of 10,000 hours in order to obtain accurate creep data.

Other factors which should also be considered in choosing the optimum tubing for a particular application are oxidation and corrosion resistance, environment, tube size, and cost.

In every instance you'll find that the broad experience available at B&W, through Mr. Tubes, is the means by which today's tubing problems are solved for tomorrow's applications. Call on Mr. Tubes, he's ready to help you.

For complete Croloy Creep Stress Data, send for Technical Data Card 102.

THE BABCOCK & WILCOX COMPANY
TUBULAR PRODUCTS DIVISION
Beaver Falls, Pa.—Seamless Tubing; Welded Stainless Steel Tubing
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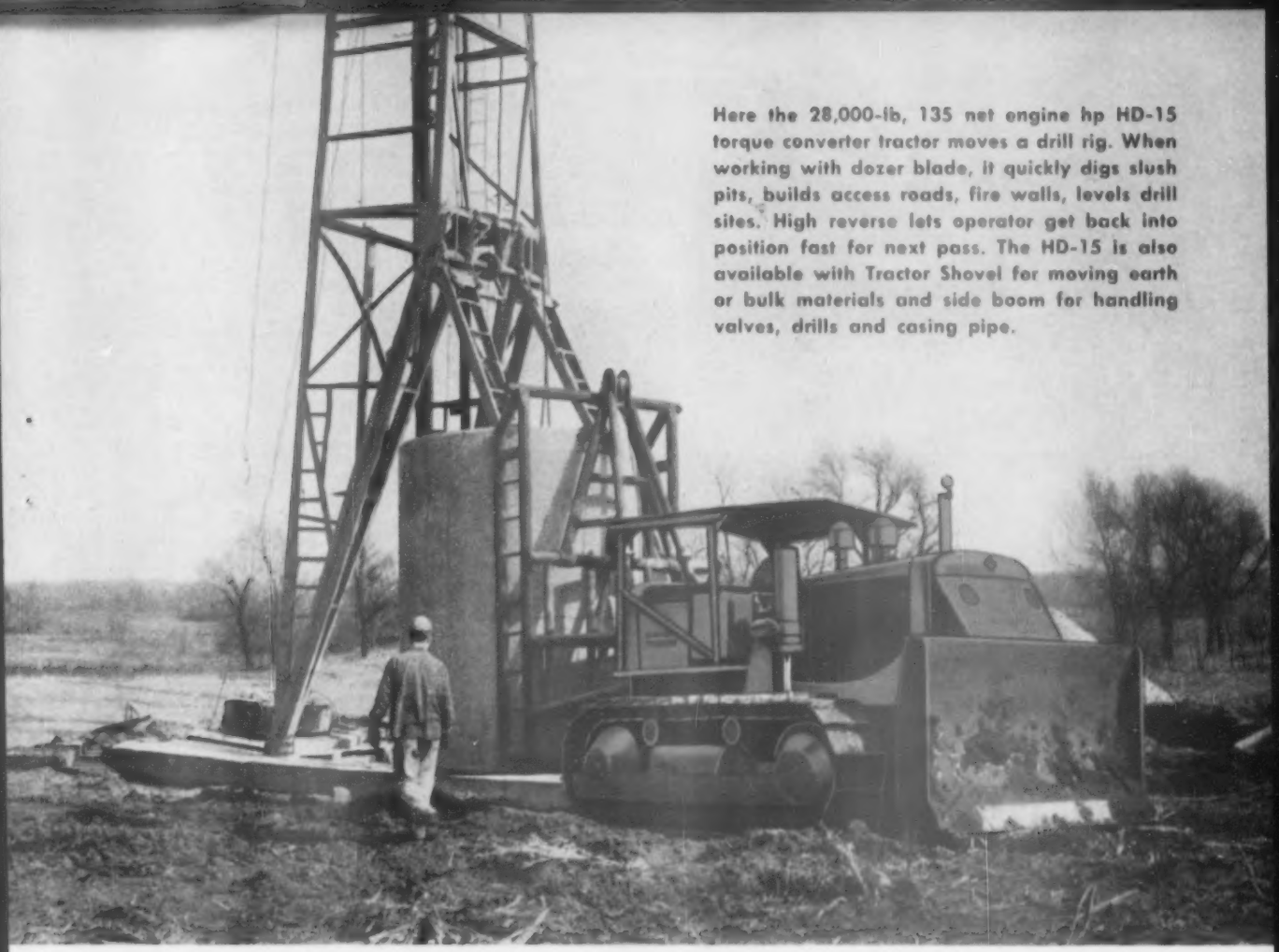
B&W SEAMLESS and WELDED TUBES

TA-4069(P)



Here the 28,000-lb, 135 net engine hp HD-15 torque converter tractor moves a drill rig. When working with dozer blade, it quickly digs slush pits, builds access roads, fire walls, levels drill sites. High reverse lets operator get back into position fast for next pass. The HD-15 is also available with Tractor Shovel for moving earth or bulk materials and side boom for handling valves, drills and casing pipe.

Power Plus on Rig Moves

Big Allis-Chalmers HD-15 shows how up-to-date tractor design with torque converter drive means greater output at lower cost.

Moving a drill rig is one of the toughest jobs an oil field tractor is called upon to do. The great weight of these towering structures puts a tremendous strain on the entire tractor. That's why the smooth, steady power build-up of an Allis-Chalmers HD-15 torque converter tractor provides such an outstanding advantage on this strenuous work. For example:

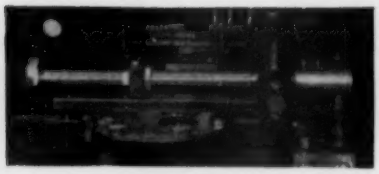
Operator shifts into the low range, eases tractor ahead until lines are taut. As he opens the throttle, power builds up smoothly, steadily. Torque actually is multiplied up to 4½ times, and, in a few seconds, the tractor and drill rig begin to ease ahead smoothly, evenly, surely. Then as inertia is overcome, the torque converter makes it possible for the tractor to accelerate automatically to highest speed conditions permit. On lighter loads operator can shift into second or third range.

Get convincing proof of the HD-15 torque converter tractor's superiority. Pick out your toughest oil field job — then ask your Allis-Chalmers dealer to demonstrate.

ALLIS-CHALMERS

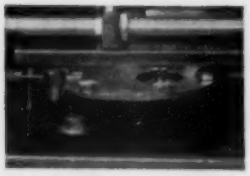
TRACTOR DIVISION • MILWAUKEE 1, U. S. A.

PROCESS CHANGES CAN'T OBSOLETE THIS TRANSMITTER . . .



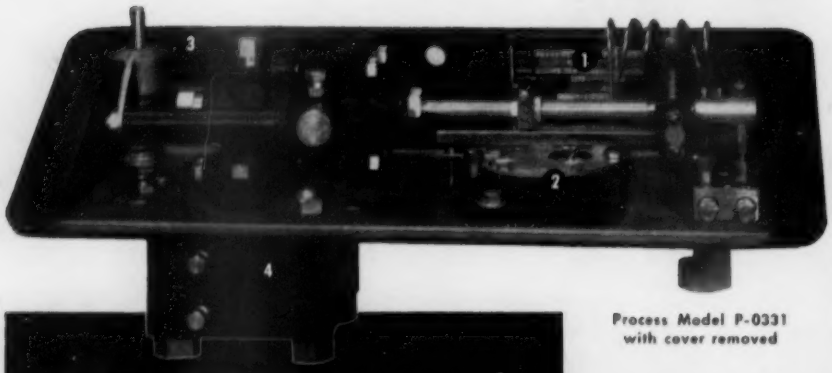
❶ 10-1 RANGE CHANGE —NO CHANGE OF PARTS

Double weighbeam construction on many models permits range changes as much as 10-1, just by turning a set of locking nuts to change a fulcrum point.

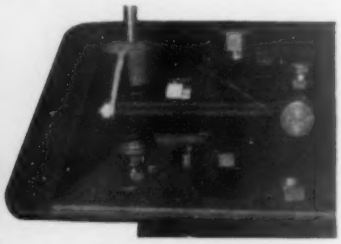


❷ ADDITIONAL 16-1 RANGE CHANGE—STILL NO PARTS CHANGE

Range may be changed on all models by loosening retaining bolts and sliding the reaction chamber to a new leverage position. Reaction area may be changed for further range change.



Process Model P-0331 with cover removed



❸ SUPPRESS, COMPOUND OR REVERSE RANGES

Balancing spring, installed to exert either an upward or downward force on transmitter weighbeam, quickly converts transmitter for range suppressions up to 80% of total range, for reversed ranges or for compound ranges where pressure fluctuates above and below atmospheric pressure.

REPUBLIC PNEUMATIC TRANSMITTER
with
EASY RANGE CHANGE

❹ MAJOR RANGE CHANGES

Range change plates may be easily inserted or removed from measuring chamber to change the effective diaphragm area for major range changes. Similar plates may be used also in the reaction chamber for further range change.

Here's the pneumatic transmitter for measuring differential, flow, pressure or level that saves you time and money when operating conditions are not definitely known or processes are likely to be changed. Extreme flexibility of design lets you adapt the same transmitter chassis for almost any range of measurements—often without any change of parts.

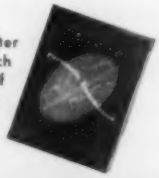
Process Model pictured above has a differential range of 0-12″ H_2O minimum and 0-880″ H_2O maximum at operating pressures to 1500 psig. Other models are available for differential ranges as low as 0-0.6 H_2O or as high as 0-750 psi.

Transmitters may be constructed of special materials to handle almost all types of corrosive fluids. Ruggedly built, they give long service out-of-doors. Accuracy is guaranteed at ½% of full range on standard models.

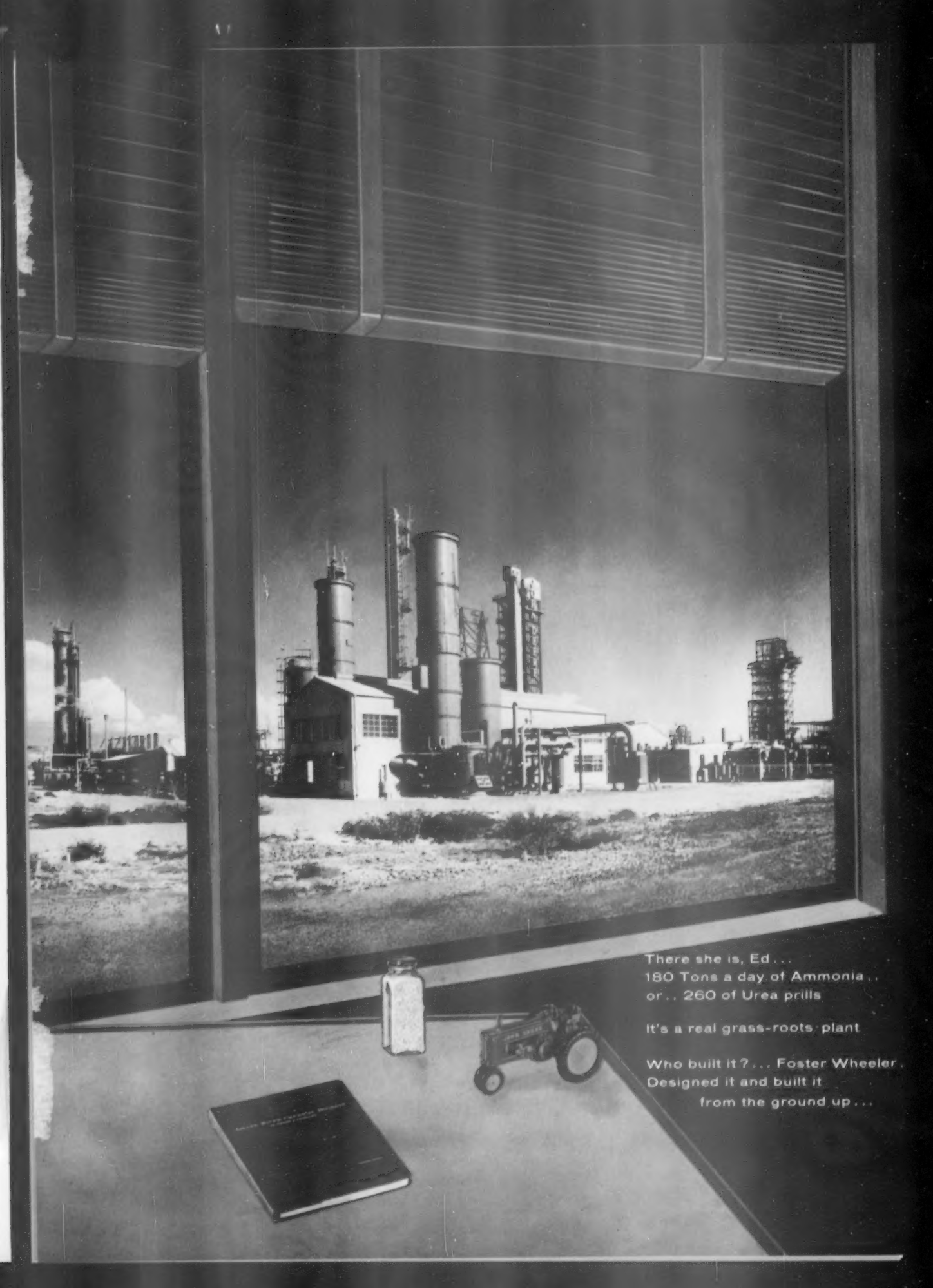
Republic transmitters are used in process, chemical and petroleum plants all over the country. Investigate their advantages for your plant.

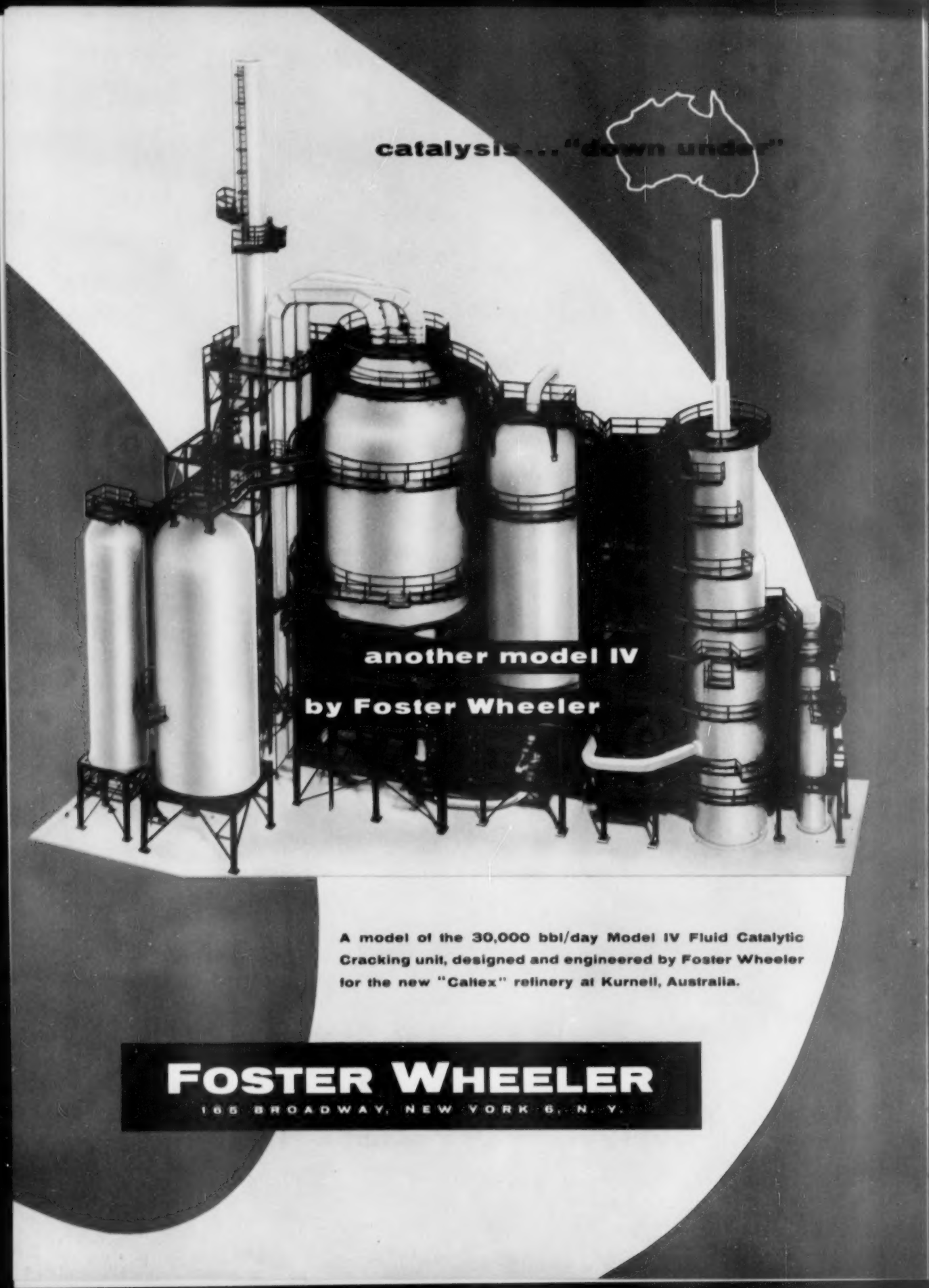
FREE DATA BOOK

Get the full story about Republic transmitter flexibility. Send for free Data Book which gives all the facts about complete line of Republic transmitters, including Square Root Extracting and Pneumatic Electric models.



REPUBLIC FLOW METERS CO.
2240 Diversey Parkway, Chicago 47, Illinois


There she is, Ed...
180 Tons a day of Ammonia..
or.. 260 of Urea prills
It's a real grass-roots plant
Who built it?... Foster Wheeler.
Designed it and built it
from the ground up...



A model of the 30,000 bbl/day Model IV Fluid Catalytic Cracking unit, designed and engineered by Foster Wheeler for the new "Caltex" refinery at Kurnell, Australia.

FOSTER WHEELER

165 BROADWAY, NEW YORK 6, N. Y.

"I was promised delivery today,

but now I'm told you've no stock of one rope and only half enough of another. This delay is costing me money and plenty of it. From now on it's Roebling for me!"

* * *

You can count on prompt and full delivery of Roebling wire rope. Your nearest Roebling office and distributor will help you choose the rope that will perform and stand up best in the oil fields. And you'll get what you want, when you want it —straight from nearby warehouse stock. District Offices at Cleveland, Denver, Houston, Los Angeles, Odessa and Tulsa.

ROEBLING

Subsidiary of The Colorado Fuel and Iron Corporation

THERE'S A ROEBLING DISTRIBUTOR IN YOUR PHONE BOOK

JOHN A. ROEBLING'S SONS CORPORATION, TRENTON 2, N. J.

Do you have this MARVEL Inverse Oiler on your { GASOLINE / BUTANE / or / DRY GAS } engine?

then you should use this MARVEL MYSTERY OIL in the Oiler!

Here's a carefully engineered pair to improve performance of any engine . . .

The *Marvel Inverse Oiler* is designed to feed *Marvel Mystery Oil* in exact proportion to engine speed and load. Prevents excess wear on valve stems and guides . . . keeps upper piston rings free to move in their grooves . . . retards ring flutter . . . and cushions ring pounding which can result in ring breakage. In addition, *Marvel Mystery Oil* reduces cylinder wall wear, and gives assurance against valves sticking. Remember, it is *the oil* which must do these things and only *Marvel Mystery Oil* is blended for this purpose and for this oiler. Over 30 years of exceptional performance.

This Chart shows the proper setting for constant load engines

BRAKE H. P. AT BELT	NAT. GAS CU. FT. PER HOUR	BUTANE GALLONS PER HOUR	GASOLINE GALLONS PER HOUR	M. M. OIL DROPS PER MIN.	M. M. OIL HOURS PER QUART
10	115.	1.07	1.12	4	228
15	172.5	1.60	1.68	6	152
20	230.	2.14	2.24	8	114
25	287.5	2.67	2.80	10	91
30	345.	3.21	3.36	12	76
35	402.5	3.74	3.92	14	65
40	460.	4.28	4.48	16	57
45	517.5	4.81	5.04	18	50
50	575.	5.35	5.60	20	45
60	690.	6.42	6.72	24	38
70	805.	7.49	7.84	28	32
80	920.	8.56	8.96	32	28
90	1035.	9.63	10.08	36	25
100	1150.	10.70	11.20	40	22
120	1380.	12.84	13.44	48	19
140	1610.	14.98	15.68	56	17
160	1840.	17.12	17.92	64	14
180	2070.	19.26	20.16	72	12
200	2300.	21.40	22.40	80	11
225	2587.5	24.00	25.20	90	10
250	2875.	26.75	28.00	100	9
275	3162.5	29.42	31.10	110	8
300	3450.	32.10	33.60	120	7

EXAMPLE:—If you use 805 cu. ft. of dry gas, 7.49 gallons of butane or 7.84 gallons of gasoline, your H.P. is about 70, so adjust oiler to feed 28 drops per minute. You will then receive about 32 hours per quart of MARVEL MYSTERY OIL.

If engine load increases after setting for normal load, oiler will automatically increase its feed, or decrease its feed when load is lessened.

When more than one oiler is used

To determine drop count per oiler when more than one oiler is used on an engine—divide recommended drop count by number of oilers.

NOTE: Guarantee on oiler is void if any other oil than MARVEL MYSTERY OIL is used therein. Some *engines* also carry this guarantee policy.

See Your Local Jobber or Oil Well Supply House

EMEROL MFG. CO. Dept. 375, 242 West 69th Street, New York 23, N. Y.

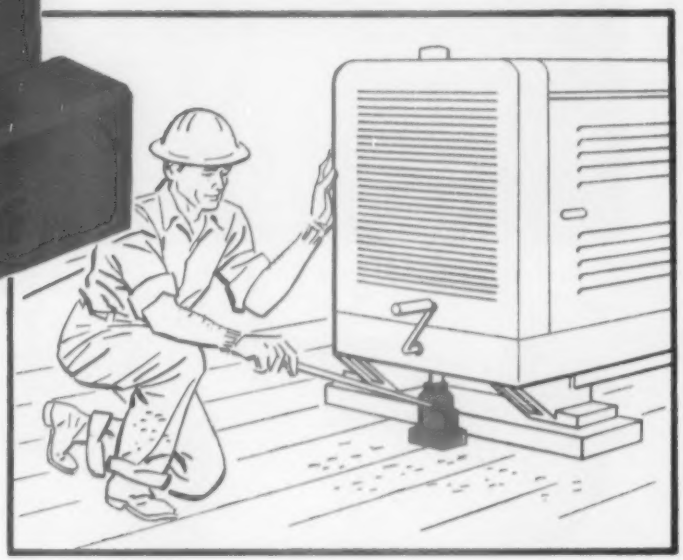
This modern jack can lift heavier loads with less effort!

This precision built jack requires much less effort to operate than mechanical type jacks because it utilizes the hydraulic principle—a pump does the work.

Duff-Norton Hy-Power Hydraulic Jacks, because of this ease of operation, are finding more widespread use in the oil fields for all kinds of heavy lifting and pushing jobs. They are standard equipment on many rig builders' trucks and on drilling rigs.

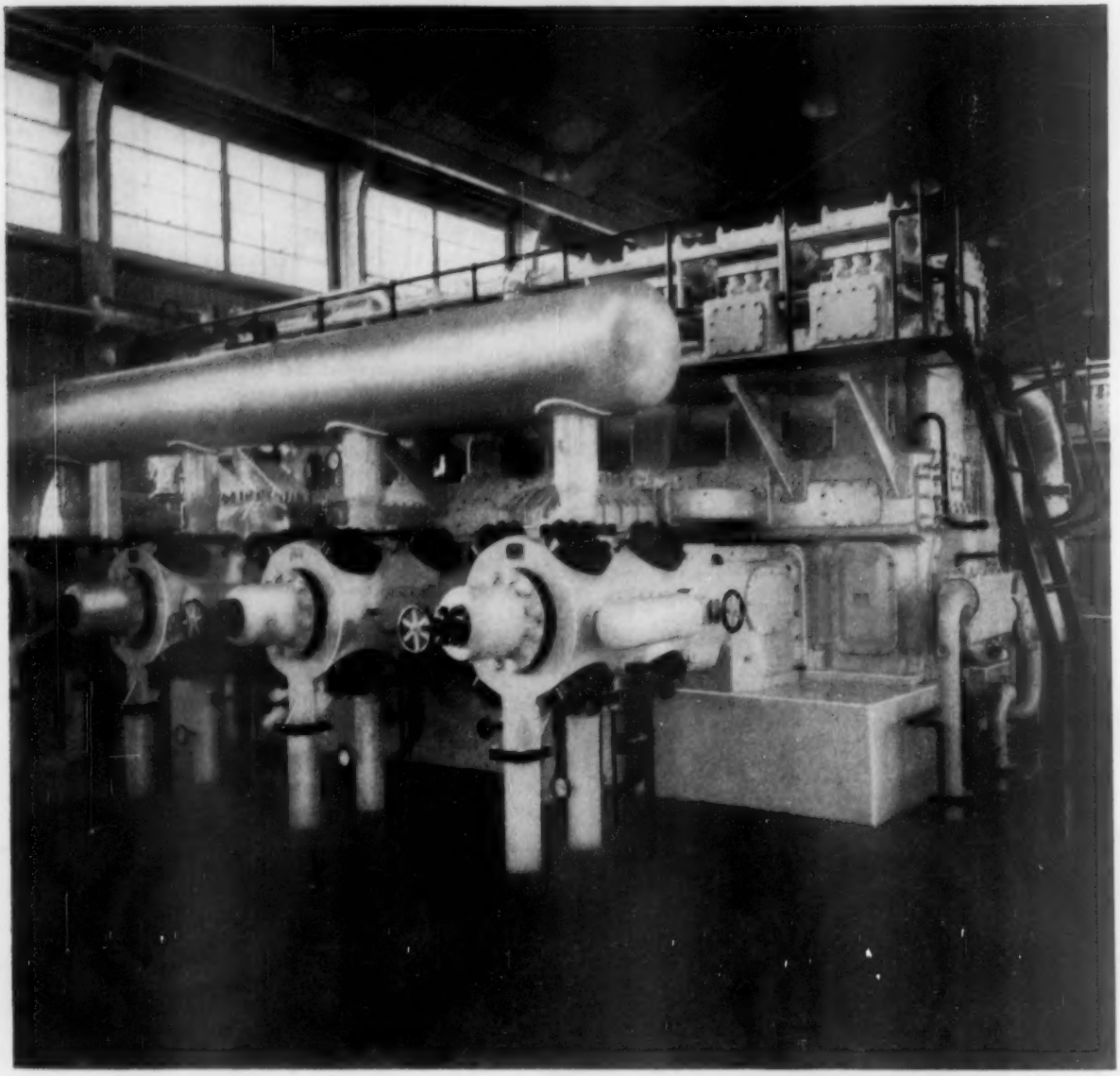
The hydraulic jack illustrated (No. 25H9) can lift 25 tons up to 6 inches. It is only 9⅜ inches high when closed and weighs only 38 lbs. There are nine other models of Duff-Norton Hydraulic Jacks with capacities from 3 to 50 tons. All models can be equipped with gauges calibrated to show exact weight of load being lifted.

See these time and energy saving hydraulic jacks at your favorite supply store or write the world's oldest and largest manufacturer of lifting jacks for complete specifications. Ask for Hy-Power Hydraulic Jack Bulletin AD16-B, The Duff-Norton Manufacturing Co., P.O. Box 1889, Pittsburgh 30, Pa. Canadian plant —Toronto 6, Ontario.

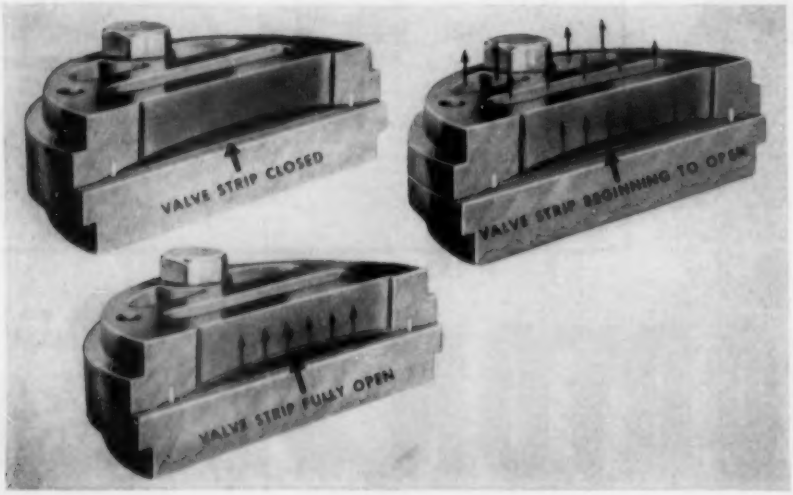


DUFF-NORTON *Jacks*

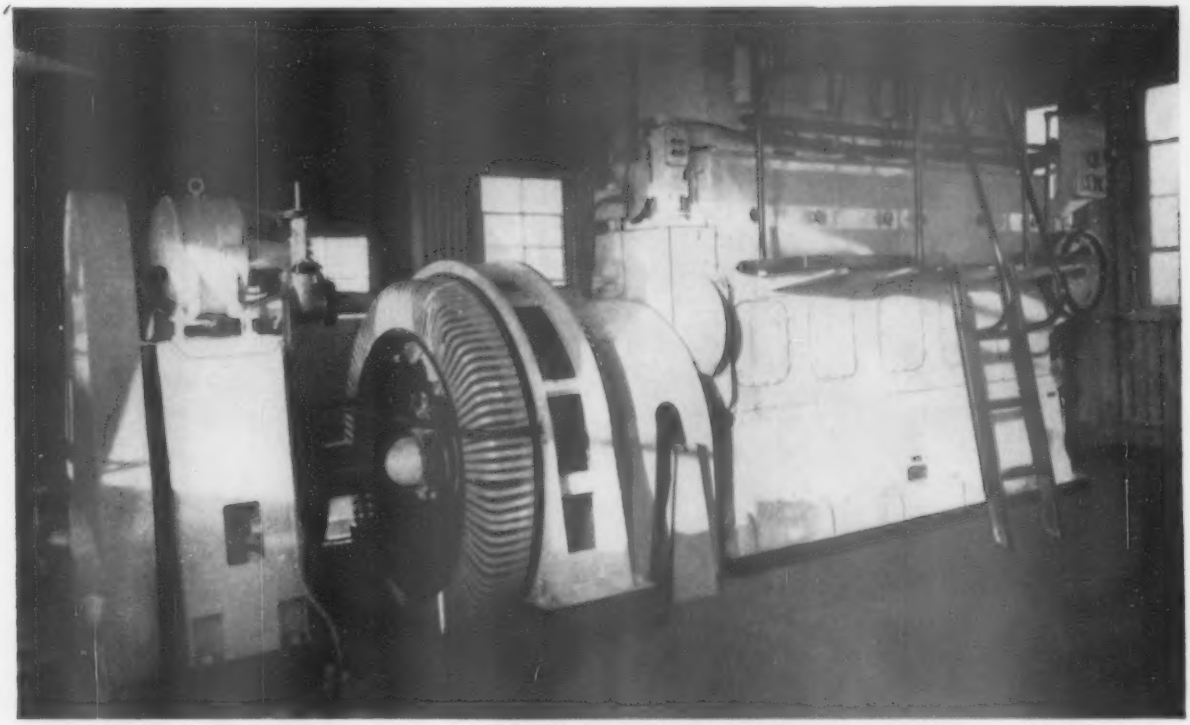
"Giving Industry A Lift Since 1883"



ONE OF FIVE MODERN WORTHINGTON UTC ENGINE-COMPRESSORS at the United Gas Pipe Line Company's McComb, Mississippi, compressor station. McComb is one of the key installations on a new 30" line that carries gas from Louisiana fields and underwater wells in the Gulf of Mexico, north to Jackson and Kosciusko, Miss. Gas is delivered to McComb at 727 psig, and the Worthington UTC's discharge the gas 68 miles north to Jackson and another 58 miles north to Kosciusko.



THE QUIET-OPERATING WORTHINGTON FEATHER VALVE, standard equipment on all Worthington compressors, is made up of a series of thin flexible strips of ribbon steel, held in position over rectangular openings by curved milled guards. In addition to providing quiet operation, the absence of impact results in long valve life and low maintenance costs.



McCOMB STATION IS MADE SELF-SUFFICIENT by this CCG-5 Worthington natural gas engine, which supplies electric power for safety system solenoids and other emergency requirements if normal power supply fails.

Sound plant design pays off in new United Gas Pipe Line Company's compressor station

• First new compressor station to go into service in United Gas' three-year $250,000,000 expansion program is the McComb, Mississippi, plant, where five 1600-hp Worthington UTC engine-compressors are in operation, designed to handle 470,000,000 cubic ft. of gas per day. End result of this expansion will be to make United Gas the first company in the world capable of handling a trillion cubic feet of gas per hour.

The benefits of good plant design and proper operation are evident at the McComb Station. Since April 3, 1952, when the Worthington UTC's were started up, the station has been remarkably free of "bugs"; there has not been a single shut-down because of engine failure.

Contributing largely to this fine record have been the time-tested features of the Worthington UTC's. For example, every Worthington compressor is equipped with the exclusive Feather* Valve — the lightest, tightest, most efficient valve available. Records show that Worthington Feather Valves have materially reduced power costs.

While Worthington UTC compressors are widely used for pipeline gas compression, they are also well suited to many other jobs, such as pressure maintenance on oil wells; varied service in natural gasoline plants; solvent extraction, vapor recovery, and recycling and stabilization of gases in oil refineries.

If your business requires gas compression, it will pay you to write for further information on the Worthington UTC Engine-Compressor. Sizes range from 1,000 to 2,000 hp. Write directly to Worthington Corporation, Engine Division, Buffalo, New York, for Bulletin S-500-B23B.

*Reg.U.S.Pat.Off.

EK.3.4

WORTHINGTON

SEE the Worthington Corporation Exhibit in New York City. A lively, informative display of product developments for industry, business and the home. Park Avenue and 41st Street.

ONLY WORTHINGTON COMPRESSORS GIVE YOU FEATHER VALVE PERFORMANCE

Y-Types • Engine-Starting • Horizontal • Portable • Radial • Gas Engine

FIGHT TRUCK FIRES THE NEW AMERICAN-LAFRANCE DRY CHEMICAL WAY

MODEL PDC-30 SHOWN IN ACTION

MODEL PDC-5

MODEL PDC-10

MODEL PDC-20

There are extra fire-fighting advantages in the faster action of the American-LaFrance Dry Chemical Fire Extinguishers on flammable liquid or electrical fires, for seconds count when fire hits, important fire-extinguishing seconds, rather than getting-ready seconds.

Simply pull pin and squeeze lever. No gadgets to operate, no last minute pressurizing from a gas cartridge or cylinder, no inverting, no bumping, no shut-off nozzle on the hose needed. They're already pressurized—ready to go!

A glance at valve gauge indicates whether unit is in operating order. When partially operated, the extinguisher can be left standing without loss of air pressure, for use on a possible reflash. Recharge promptly when danger of reflash is over.

Write for illustrated literature, or for a demonstration. We have representatives in all principal cities.

Approved by Underwriters' and Factory Mutuals Laboratories for Class B and C fires.

Model number designates the pound capacity of each extinguisher.

MODEL PDC-30

OUR 2nd Century of Leadership in FIRE PROTECTION

AMERICAN-LAFRANCE-FOAMITE Corporation

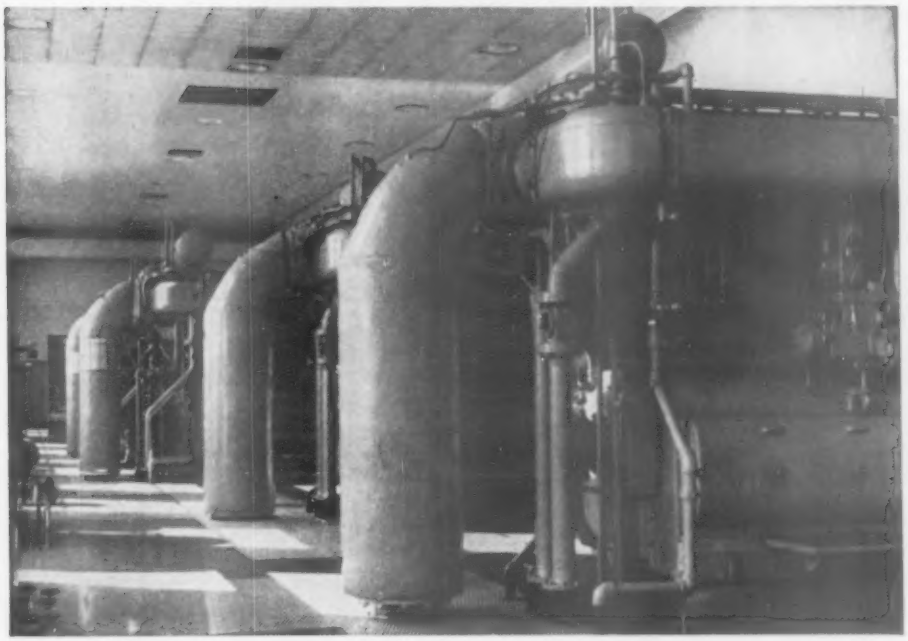
ELMIRA · NEW YORK · U.S.A.

IN CANADA, LAFRANCE FIRE ENGINE & FOAMITE LTD., TORONTO

Another Pipe Line Company Reports

2 to 3 times more horsepower hours

. . . after installing Koppers Conformable Oil Rings



Koppers Porous Chrome* Rings. Porous chrome surface holds and distributes oil during break-in. Seats quickly. This chrome prevents grit from embedding in ring surface. Prevents cylinder wall scratching. Reduces wear 50%. Last 4 times longer than other rings.

Koppers Conformable Ring maintains constant unit pressure for positive oil control. Conforms readily to meet cylinder distortion because flexible cast iron member is pressed outward by abutment type spring which exerts uniform radial pressure around entire circumference.

*Van der Horst Process

Here's proof that Koppers Piston Rings increase operating efficiency.

Prior to using Koppers Conformable Oil Rings, a pipe line company reported average oil consumption as approximately 3500 to 4000 horsepower hours per gallon. Now they are getting 2 to 3 times that much.

In addition to this large saving in oil consumption, they find they get longer periods of satisfactory operation between overhauls.

As a result, this pipe line company has adopted Koppers Piston Rings as standard equipment on all their 12½" x 13" turbo-charged engines.

Does this suggest possible savings in your operation? Less oil consumption? Less down time, lower labor costs? Then investigate Koppers Porous Chrome* and Conformable Oil Rings. And install them next time you have a piston ring replacement job.

Write for special assistance from our experienced technical staff. No obligation, of course . . . . and mail the coupon for special conformable ring folder.

KOPPERS®

AMERICAN HAMMERED
Industrial Piston Rings

METAL PRODUCTS DIVISION • KOPPERS COMPANY, INC. • Baltimore, Maryland
This Koppers Division also supplies industry with Fast's Couplings, Aeromaster Fans, Koppers Electrostatic Precipitators and Gas Apparatus.

Engineered Products Sold with Service

KOPPERS COMPANY, INC., ***Piston Ring Dept.,*** **1651 Hamburg Street, Baltimore 3, Md.**
Gentlemen: Please send me full information on your Conformable Oil Ring.

Name .....

Company .....

Address .....

City ..... Zone ..... State .....

World's best trucks... by actual comparison!

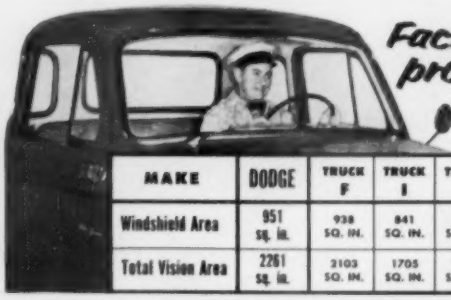
Most powerful low-tonnage truck engine!

Here's proof

New Power-Dome V-8 delivers sensational 145 hp. . . . more than any other low-tonnage truck engine

	DODGE	TRUCKS F	I	G	C
Max. HP. of leading ½-, ¾-, 1-ton trucks	145-hp.	130-HP.	126-HP.	125-HP.	112-HP.
HP. per cu. in. displacement	.601	.544	.524	.503	.476

Best truck visibility!



Facts prove it

MAKE	DODGE	TRUCK F	TRUCK I	TRUCK G	TRUCK C
Windshield Area	951 sq. in.	938 SQ. IN.	841 SQ. IN.	728 SQ. IN.	728 SQ. IN.
Total Vision Area	2261 sq. in.	2103 SQ. IN.	1705 SQ. IN.	1890 SQ. IN.	1890 SQ. IN.

Sharpest turning trucks!

and here's the proof...

Make of ½-ton Pick-Up	No. of ft. for U-Turn
DODGE	36¾'
TRUCK F	37½'
TRUCK I	38½'
TRUCK G	41'
TRUCK C	39½'

Roomiest truck cab!

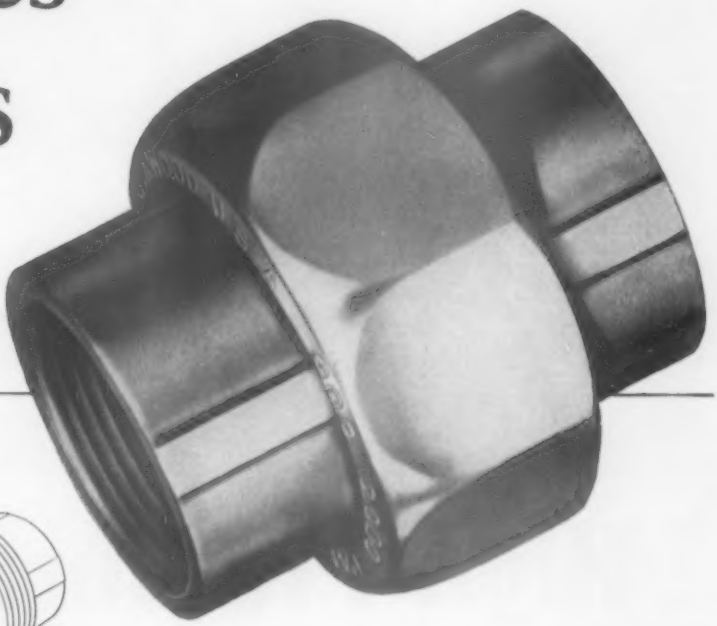
Here's proof!

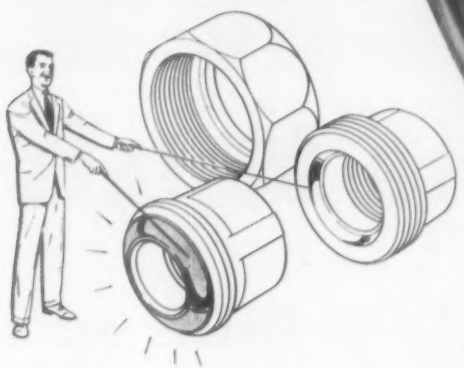
Make of Truck	Hip-room	Shoulder-room	Seat Height
DODGE	61¾"	58⅜"	16"
TRUCK F	60½"	56⅛"	15½"
TRUCK C	60"	55½"	14⅛"
TRUCK G	60"	55½"	14⅛"
TRUCK I	58⅛"	57"	13⅞"

DODGE "Job-Rated" TRUCKS

ASK US TODAY ABOUT A BETTER DEAL FOR THE MAN AT THE WHEEL!

Unique performance
of new Rockwood Union #603
amazes users





No galling in "making up"!

"There's no other Union like it!" users tell us.

And they're quite right.

No other Union has the hardness-differential that makes Rockwood's remarkable new Union #603 unique. *The male seat of this new Union is specially treated to give it a greater degree of hardness than the female seat.* Result: no galling in "making up" — longer service.

Users find that this hardness-differential, coupled with the many other Rockwood features, brings them Union performance unheard of before. They also praise these additional Rockwood advantages —

- V exclusive cold forging process that results in higher resistance to tough working conditions
- V absolutely interchangeable parts
- V plug type ball-to-cone design that eliminates sharp corners or edges, does away with scratching when making up in tight places
- V exclusive "Rockwoodizing" that protects entire Union, including threads, against corrosion

Both seats of the new Union #603 are made of corrosion-resistant AISI molychrome steel, forged in place and bonded-locked under 100,000 and 400,000 pound pressure.

If you have not already started using this remarkable new Union, plan now to do so. For complete facts, mail coupon today.

ROCKWOOD SPRINKLER COMPANY
WORCESTER 5, MASSACHUSETTS

ROCKWOOD

ROCKWOOD SPRINKLER COMPANY
631 Harlow Street
Worcester 5, Mass.

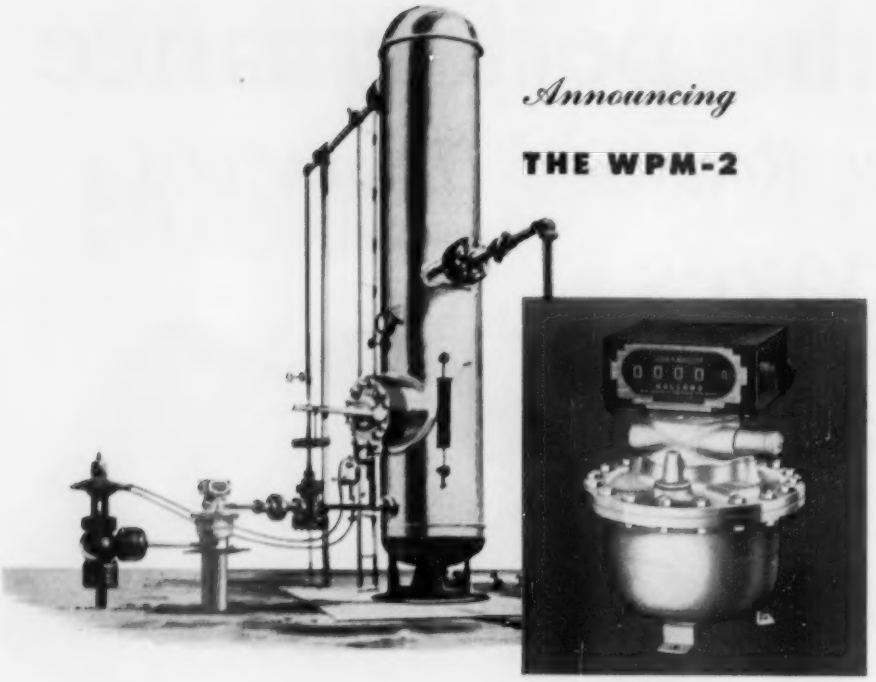
Please send me prices and further data on the new Rockwood Union #603. I would also like the name of the nearest Rockwood distributor.

Name.....

Title.....

Company.....

City..... Zone..... State.....



Announcing

THE WPM-2

The WPM-2 is ideally suited for crude oil production, LPG, additives and other applications. Unit is designed for 300 psi. working pressure for flow rates of 1 to 25 gpm. May be equipped with standard SMITHway counters and automatic temperature compensation to 60° F.

A NEW SIZE IN OUR LINE OF

High Pressure Meters

Through research A.O. Smith *. . .a better way*

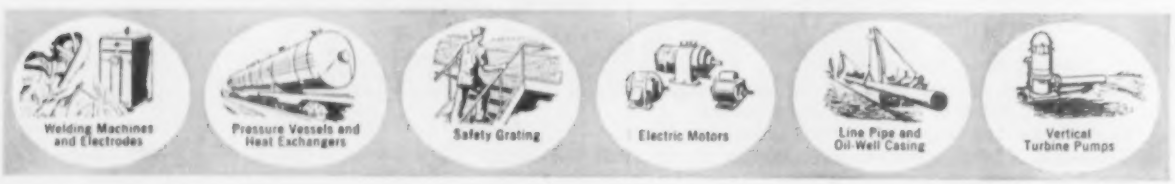
A.O.Smith
CORPORATION

METER DIVISION

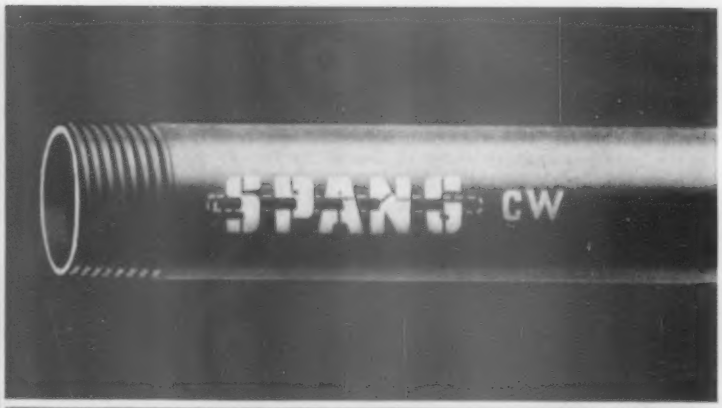
Factories: 5715 Smithway St., Los Angeles 22, Calif., P.O. Box 500, Succasunna, N. J. Offices: Atlanta, Chicago 7, Houston 20, Los Angeles 22, New York 17. Canada: Toronto 12, Vancouver 1. International Division—Milwaukee 1, Wis.

A. O. Smith Meters are now available in eight sizes for six pressure ranges and flow rates from 1 to 2000 gpm. Send for Bulletins 126-A and 166.

A. O. Smith Meters give you positive records for tax and royalty purposes. In addition, you avoid as much as 34% shrinkage and product loss.



Profit 3 ways with SPANG CW steel pipe in your oil country water systems



You can't beat SPANG CW Steel Pipe for service on water systems, flooding lines and salt water disposal lines! The reason is SPANG *quality control.*

This means that only top-grade steel goes into the manufacturing of SPANG CW . . . close control is maintained throughout forming and welding . . . each length of pipe is rigidly tested and inspected before shipment.

Here's what *quality control* means to you for water system installations in the oil country:

1. **Faster Installation**—*Quality control* makes SPANG CW uniform in every respect . . . makes it easier to cut, bend and thread . . . saves you money.
2. **Greater Dependability**—*Quality control* through automatic control of heat during forming and welding gives SPANG CW strong, clean, uniform welds . . . assures added pipe strength.
3. **Longer Service Life**—*Quality control* means SPANG CW is free of scale inside and out . . . providing smoother corrosion-resistant surfaces, longer life.

These advantages add up to real savings and trouble-free performances in oil country water system installations. And SPANG CW is tops for gas, air and oil gathering lines, too!

You can get SPANG CW Steel Pipe in a full range of sizes from your nearby National Supply Store. Try SPANG CW in your operations. It will pay off for you!

NATIONAL BLUE PRODUCTS

SPANG-CHALFANT DIVISION

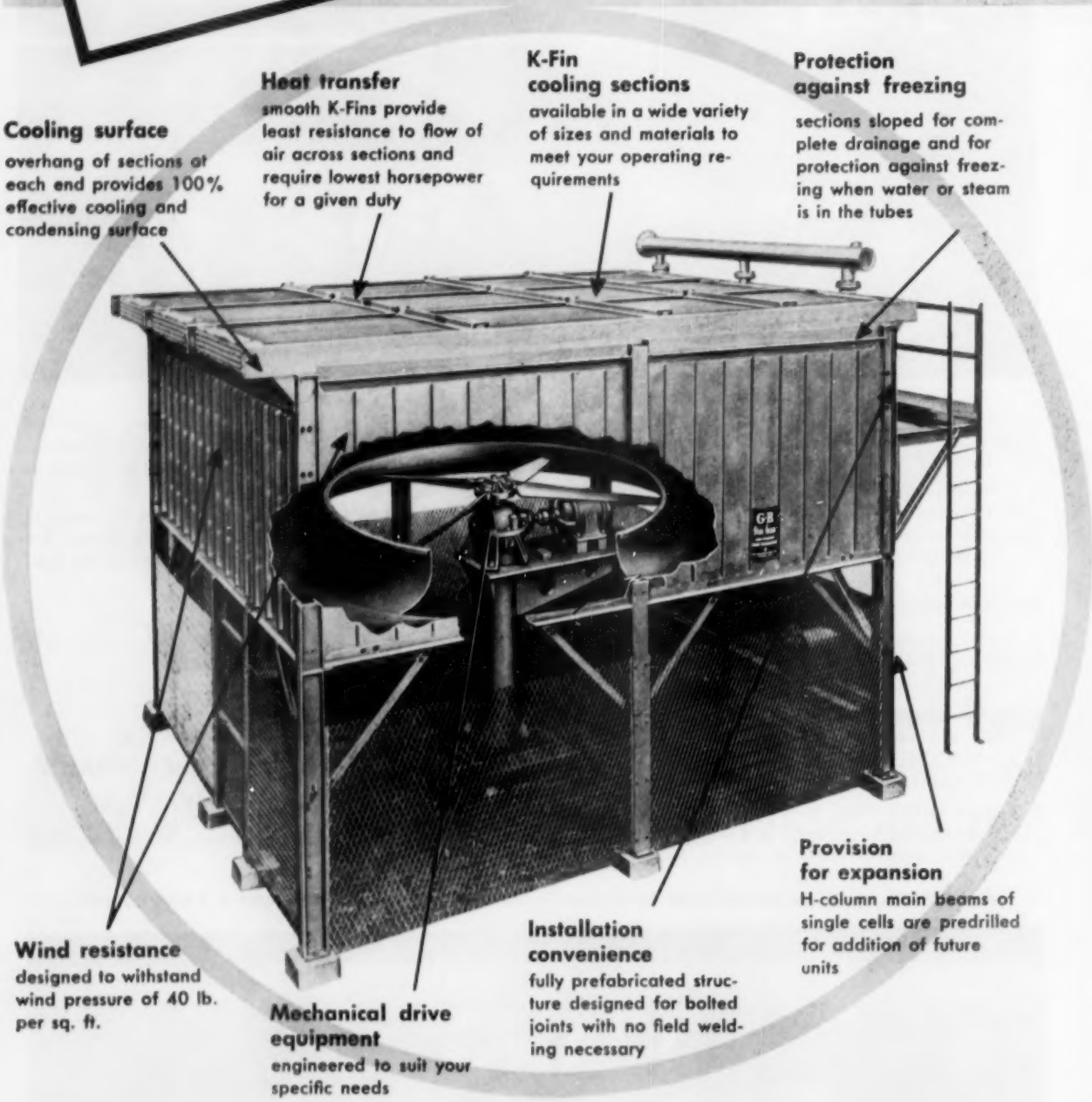
THE NATIONAL SUPPLY COMPANY

PITTSBURGH 30, PENNSYLVANIA

DIVISION TUBULAR OFFICES: Denver, Colorado • Houston, Texas • Fort Worth, Texas
Los Angeles, California • Pittsburgh, Pennsylvania • Tulsa, Oklahoma
Calgary, Alberta, Canada

NATIONAL OIL FIELD MACHINERY AND EQUIPMENT • SPANG STEEL PIPE • SUPERIOR & ATLAS ENGINES

a dependable air-cooled



Cooling surface
overhang of sections at each end provides 100% effective cooling and condensing surface

Heat transfer
smooth K-Fins provide least resistance to flow of air across sections and require lowest horsepower for a given duty

K-Fin cooling sections
available in a wide variety of sizes and materials to meet your operating requirements

Protection against freezing
sections sloped for complete drainage and for protection against freezing when water or steam is in the tubes

Wind resistance
designed to withstand wind pressure of 40 lb. per sq. ft.

Mechanical drive equipment
engineered to suit your specific needs

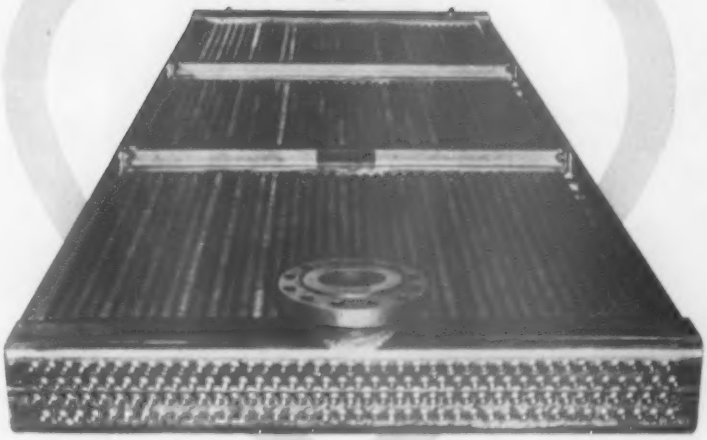
Installation convenience
fully prefabricated structure designed for bolted joints with no field welding necessary

Provision for expansion
H-column main beams of single cells are predrilled for addition of future units

heat exchanger

...guaranteed by G-R

The new G-R **fin-fan** has several important advantages of design and construction. Its distinctive features are based on the records of **fin-fan** installations all over the world and supplemented by results obtained from advanced designs of transfer surface, structure, and drive mechanism. The complete unit can be depended upon for strength, effectiveness, and convenience of installation, operation and maintenance.



K-Fin Cooling Section

the heart of the G-R fin-fan Air-Cooled Exchanger

Here is an air-cooled section that is based on a heat transfer experience of more than 80 years, and the results obtained from many millions of square feet of extended surface operating on all kinds of air-cooled duties.

G-R K-Fin Sections can be furnished for pressures all the way up to 9000 psi and for temperatures as high as 1500F. The K-Fin elements can be made of the metal or alloy best suited for the particular fluid you handle. The fins are secured to the tubes by a patented mechanical process that has proved its long-lasting bond for over 25 years, and in many thousands of installations of G-R air-cooled units.

The entire K-Fin structure has proved itself to be amply strong and rugged. It is the same structure used in more than 15,000 G-R Bentube Sections, as well as in **fin-fan** installations all over the world.

Because of this unmatched experience, G-R air-cooled exchanger design, construction and ratings are authoritative and are fully guaranteed. You can rely on G-R recommendations and on G-R **fin-fan** installations.

THE GRISCOM-RUSSELL CO., MASSILLON, OHIO

G-R HEAT TRANSFER APPARATUS **fin-fan Air-Cooled Exchanger**

GR-322

powered for Performance

26' Bryant-built stock work boat, 25 H.P. Evinrude outboard motor installed in stern well.

BIG TWIN

25 O.B.C. certified B.H.P. at 4,000 R.P.M. Gearshift, separate plug-in fuel tank.

PROVED PERFORMANCE! No "maybe" when it came to picking the power plant for this husky work boat. In identical hulls the Evinrude 25 H.P. Big Twin had conclusively proved its advantages over conventional engine installations of the same rated horsepower. Higher speed, light or loaded. Greater maneuverability. Important space saving. Easy beaching. *Far lower cost*—as much as $900 *less* than the conventional installations.

With *performance,* an Evinrude gives you stamina and low upkeep you couldn't beat in any type of motor. A complete line, 3 to 25 H.P., to meet the widest range of work boat needs. See your Evinrude dealer—look for his name under "Outboard Motors" in the yellow pages of your phone book. For complete literature write EVINRUDE MOTORS, 4527 North 27th Street, Milwaukee 16, Wisconsin.

In Canada: Manufactured by Evinrude Motors, Peterborough, Ontario

Big Twin is also available in 20" extra depth model suitable for transom heights to 35". Photo shows Bristol Bay, Alaska, sailing gillnetters converted to power with this motor.

EVINRUDE

OUTBOARD MOTORS

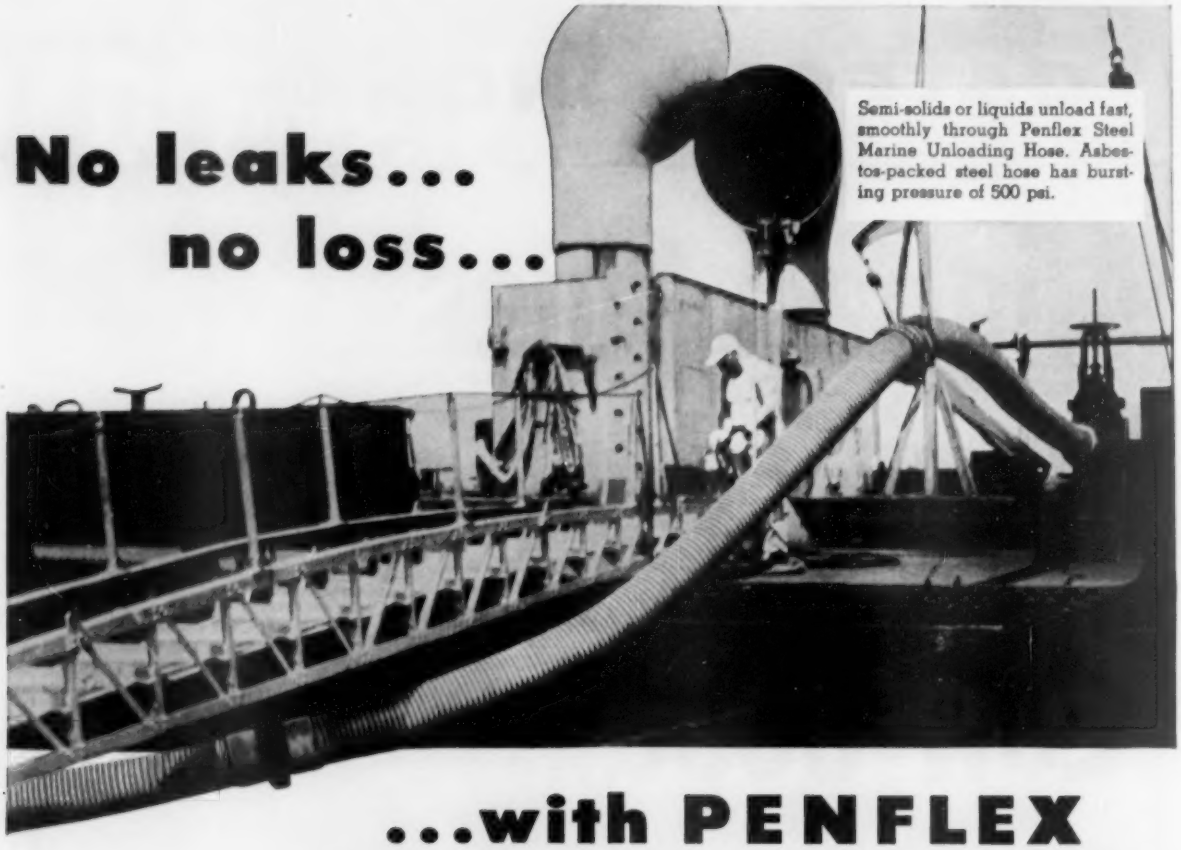
CATFORMING *means*

High Octanes...
High Yields...
Low Cost...
Proved Performance

These advantages of Atlantic Catforming are being demonstrated again and again in different commercial installations. We invite you to share in the benefits of Catforming. Please phone, write or wire for our detailed brochure, "CATFORMING." The Atlantic Refining Company, Research and Development Dept., P. O. Box 8138, Philadelphia, Pa.

ATLANTIC *It's the Catalyst that counts*

No leaks... no loss...



Semi-solids or liquids unload fast, smoothly through Penflex Steel Marine Unloading Hose. Asbestos-packed steel hose has bursting pressure of 500 psi.

...with PENFLEX ship-to-shore transfer

Pipe "walks" with tank thanks to Penflex four-wall Interlocked Packed Tubing (12" I.D.) and matching threaded flanges. Galvanized steel is used and stainless is also available.

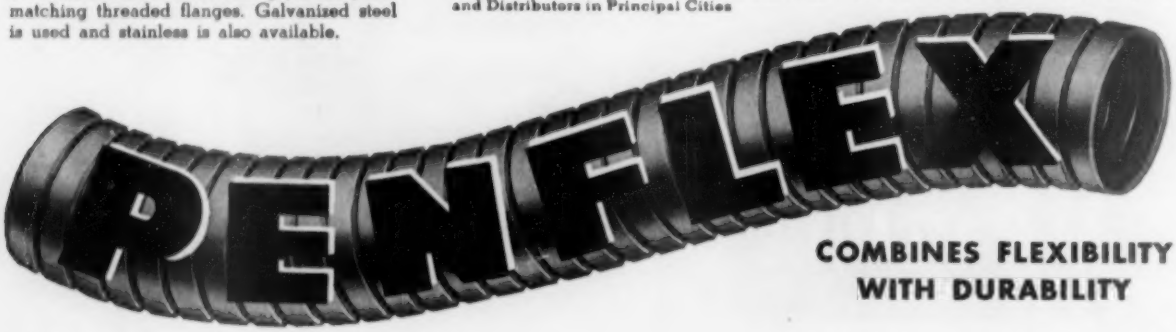
Afloat and ashore Penflex Flexible Metal Hose guards your "waste-line." One big processor uses Penflex at two critical points—ship-to-shore transfer and storage.

The cargo is pumped from the hold through 25-foot lengths of Penflex Steel Marine Unloading Hose (8" I.D.). This rugged hose rides with the tide and permits full flow.

Penflex serves again in shore storage tanks. Here it's a "give-and-take" proposition as outdoor temperature rises and falls. The easy flexing tubing provides tight, leakproof connections for intake and outlet pipes. When the tank expands or contracts, Penflex "walks" with it.

Somewhere in your plant or storage facilities you need Penflex to cushion shock . . . soak up vibration . . . convey gases, oils, volatiles, or granulars safely. Our data booklet, "Flexineering," suggests dozens of applications of Penflex Interlocked Tubing and Penflexweld High-pressure Tubing. Write for it today.

Pennsylvania Flexible Metallic Tubing Company, Inc., 7213 Powers Lane, Phila. 42, Pa.
Branch Sales Offices: **Boston • New York • Chicago • Houston • Cleveland • Los Angeles and Distributors in Principal Cities**



COMBINES FLEXIBILITY WITH DURABILITY

They Say—

Don't Be Hoggish

"What we mean by all this is that it never pays to be hoggish. And unfortunately a lot of people in this very business . . . has been so very hoggish, or at least have tried to be so hoggish that they have set up pressures and backfires that are now likely to destroy or at least injure the industry . . . There is too much of supply in the oil business. Too much physical material. Too much pressure for physical advantage, too much pushing for business in ruthless, senseless ways. Understand I am for competition. I have tried to be strongly competitive all my life. But there comes a point where it is simply better not to be too grabby, too ambitious, too far-reaching.

". . . I urge you to reach back into your consciences when you decide how much to make and how much to throw on the market and how low to cut the price . . . You are dealing with the future of the greatest system of human life the world has ever known—the greatest in principle. And you are deliberately endangering it when you conduct your enterprise out of harmony with the needs of the occasion.

"Watch supply, Mr. Individual Oil Industry Business Men. There is too much. You can hurt yourself, your enterprise, your industry, and the public by 'too much.'"

Bernard L. Majewski, president, Signal Perfect Fuels, Inc., in an address before the annual meeting of the California Natural Gasoline Association.

Tapping the Williston

"We've tapped only a relatively few of the Williston basin's 130,000 or so square miles of potential oil-producing lands. We've managed to find only a small fraction of the 2½-billion-barrel reserve that so many experts have confidently said is locked there. . .

"We'd have run out of oil in this country 50 years ago if it weren't that competition for a legitimate profit led wildcatters to drill even in unlikely places.

"Without competition we'd never have had gasoline prices held down to a point at which today an hour's average wage will buy 7.8 gal. of gasoline as against the 3.2 gal. that could be bought with 1929's average hour wage."

A. C. Sailstad, Chicago, general sales manager of Standard Oil Co. (Ind.), in an address before the Billings, Mont., Chamber of Commerce.

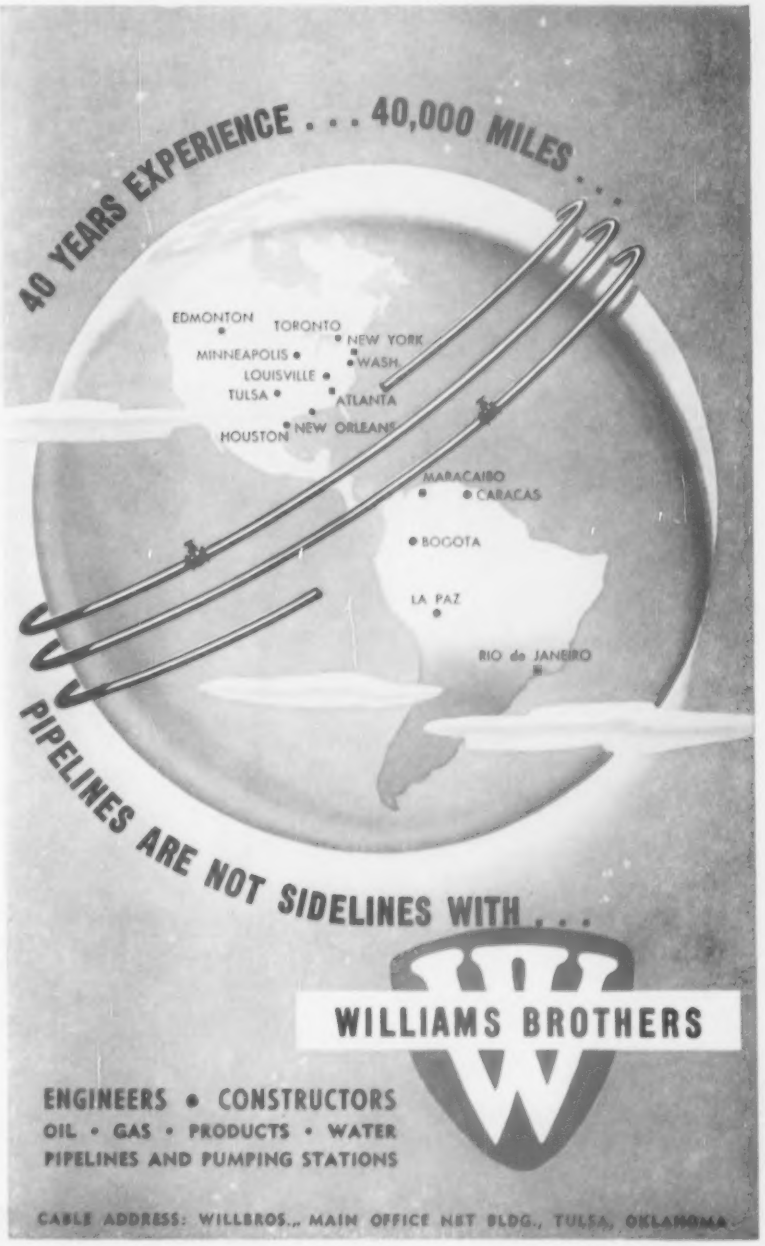
Loading At Abadan

"Mr. Mossadegh's belief was that the agreement between the government of Iran and the Anglo-Iranian Oil Co. made in 1901 and revised under the good offices of the League of Nations in 1933 was unfair. It may have been. Signed in the midst of world depression, it gave the Iranian Government 20 per cent of the amount received by the ordinary stockholders of Anglo-Iranian.

"The new agreement . . . gives the Iranian Government 50 per cent of the net operating revenue in lieu of income taxes . . . During the next 3 years, Iran will receive $420,000,000 or more . . .

"Former Premier Mossadegh . . . may have thought himself a sincere patriot. He may have thought that he was fighting Western 'imperialism.'. . .

"Imperialism is outdated in a democratic world. What we want is cooperation with the rights of an Iranian on the same level, no higher and no



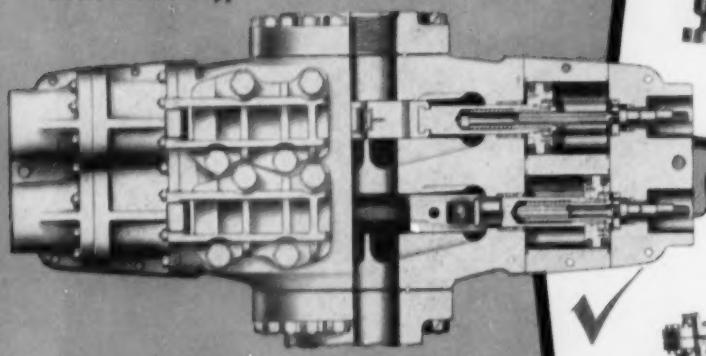
Check these pressure control features-

In every unit you get the best value from

SHAFFER

Regardless of your pressure control requirements, you get greater *compactness*, greater *adaptability*, greater *operating simplicity* and more *advanced features* when you chose SHAFFER. Shaffer not only offers the industry's most complete line of pressure control equipment, but every unit is backed by well over a quarter-century of leadership and "know-how."

These units are typical. Check them over . . .



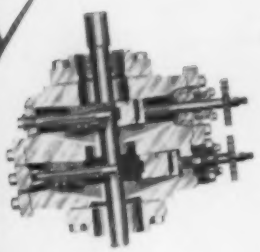
SHAFFER HYDRAULIC CELLAR CONTROL GATES

combine proven dependability with maximum compactness!

- Side-opening doors permit quick, easy ram changes without need for expanding critical height or length dimensions to allow room for changing rams.
- To change rams, simply open the door, replace the rams, then bolt the doors shut again. Closing the doors automatically aligns the rams in the Gate. In Shaffer Double Gates, there is no need to disassemble the upper compartment to change rams in the lower compartment. Rams in either compartment can be changed separately and independently — without disturbing the other!
- Available in both Double (illustrated) and Single types to provide maximum flexibility for various well requirements. Even in sizes as large as 13⅝" (12" Series 900) the Double Gate provides two ram compartments in an overall height of only 30". Smaller sizes require even less space!

There are many other unique features. Be sure to get the complete story before you buy *any* control gate equipment. Available in a complete range of sizes and pressure ratings!

SHAFFER



SHAFFER MECHANICAL CELLAR CONTROL GATES

- Available in both Double (illustrated) and Single types for operation by compact air drives—plus manual stand-by!
- Require very little space—less than 29" in height for the Double Gates in sizes as large as 13⅝" (12" Series 900)—smaller sizes even less!

Easy ram changes . . . Self-draining gate bottoms . . . Quick, easy installation, and many other advantages make these Gates outstanding where mechanical operation is desired!

SHAFFER

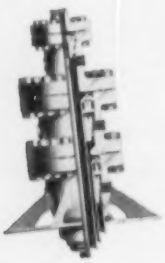
SHAFFER COMBINATION ROTATING BLOWOUT PREVENTERS AND STRIPPERS

—combine in one unit every necessary feature for simplified pressure control while drilling!

- Available in two types—Type 50 for all kinds of drilling operations, including drilling through 10¾" casing and larger . . . and Type 51 for slim hole drilling, drilling-in, production and re-work jobs.
- Both maintain a continuous seal around the various diameters and shapes in the drill string—round, square or hexagonal—whether the string is rotating, being raised or lowered, or is stationary.

Nothing else combines the simplicity and safety of this equipment for pressure control while the drill string is in the well.

SHAFFER



SHAFFER LANDING, CASING AND TUBING HEADS

—there's a size and type to meet your requirements!

- Available in a wide range of types and packing designs.
- For maximum compactness, Base Heads and Combination Base, Casing and Tubing Heads are available for combining several units in one.

No matter what your well completion problem, Shaffer can supply field-proven Landing, Casing and Tubing Heads to meet your requirements.

SHAFFER

SHAFFER ADJUSTABLE FLOW BEANS

- Ideal for controlling fluid flow on drilling and producing wells, in refineries, gas plants and other operations where accurate control of fluid flow is essential.
- Available with Conical, Micro and electrically-heated Thermo Tips (both regular and hard metal) in all popular sizes with either flanged or screwed connections.

SHAFFER

HIGH PRESSURE DRILLING AND CONTROL EQUIPMENT • FISHING TOOLS THAT EXCEL

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FARMINGTON, NEW MEXICO, Shaffer Tool Works, Post Office Box 566
CASPER, WYOMING, Shaffer Tool Works, Post Office Box 1788
EXPORT SALES OFFICE: Shaffer Tool Works, 500 Fifth Avenue, New York, N. Y., U.S.A.

31 years OF OIL TOOL LEADERSHIP

Get complete details on the Shaffer line of pressure control equipment—and the most advanced Fishing Tools—by sending for your free copy of the Shaffer Catalog!

See the Shaffer Section of your Composite Catalog!

lower, as those of an Englishman, Netherlander, or American. But the Mossadegh way of combating what may or may not have been imperialism was wickedly wasteful. Everybody concerned . . . can feel a little more secure as . . . tankers move up to load oil at the port of Abadan."

Editorial in the New York Times.

Pipelines In Future Wars

". . . When General Patton's Third Army ran out of gas near Metz, it was supplied by truck only at fantastic cost in fuel. His experience emphasized the point that as a practical matter, ground forces cannot move forward unless railroads or pipelines keep pace, and pipelines require much less manpower, material, and time than railroad construction. Time and again during the war we brought pipelines even within artillery range for the enemy.

"In the fast-moving wars of the future, pipelines may not be able always to follow that closely. It is all the more important . . . to plan the construction of our military pipelines as integral elements of the strategic and logistic plan . . . with the accent on speed and facility of construction. Pipelines are a basic part of the complex system of troop support which we call the line of communications . . .

"In future wars, we can no longer count on travelling by road; we will move in dispersed formations across country—but the pipelines remain indispensable, indeed more so than ever . . ."

Maj. Gen. S. D. Sturgis, Jr., Chief of Engineers, U.S.A., in an address before the Construction Division, American Society of Civil Engineers, at a New York meeting.

Conservation vs. Control

"Texans were a little slow in waking up to the importance of the issues involved in the tidelands case. Now the state is confronted by another Supreme Court decision which . . . is . . . in the same classification. It is the decision in the Phillips case, which practically turns over to the Federal Power Commission the regulation of the Texas gas industry.

"The great danger in this type of decision is pointed up in a story . . . telling of the conflict between the Railroad Commission of Texas and the

VICTAULIC
METHOD OF PIPING

FOR GROOVED PIPE

Style 77 & 77-D

Style 78
VICTAULIC SNAP-JOINT

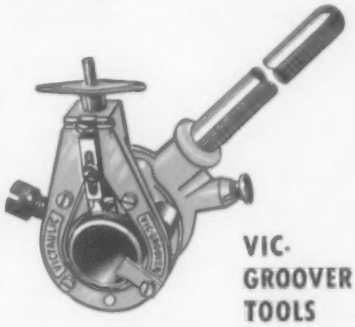
New, boltless coupling — hand-locks — for faster hook-ups with no loose parts. Ideal for temporary or permanent lines. Sizes 1", 1¼", 2", 3", 4".

VICTAULIC COUPLINGS

Style 75

Style 77 & 77-D—The "general-purpose" couplings for standard applications. Simple, fast, reliable—sizes ¾" to 60".

Style 75—Light Weight Couplings—for low pressure, low external stress applications. Sizes 2", 3", 4".



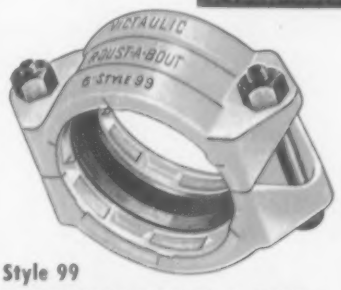
VIC-GROOVER TOOLS

Handy, on-the-job grooving tools that do the work in half the time. Light weight, easy to handle, operate manually or from any power drive. Automatic groove position and depth. Sizes ¾" to 8".

VICTAULIC FULL-FLOW FITTINGS

Streamlined for top efficiency, easy to install—complete line, Elbows, Tees, Reducers, Laterals, etc., — fit all Victaulic Couplings. Sizes ¾" to 12".

FOR PLAIN END PIPE



Style 99
VICTAULIC ROUST-A-BOUT COUPLINGS

Best engineered, most useful plain end joint on the market! Simple, fast, husky. Easy to install with any socket wrench. Takes strong, positive, bull-dog grip on pipe. Sizes 2" to 8".

Promptly available from distributor stocks coast-to-coast. Write for NEW Victaulic Catalog and Engineering Manual No. 54-8F.

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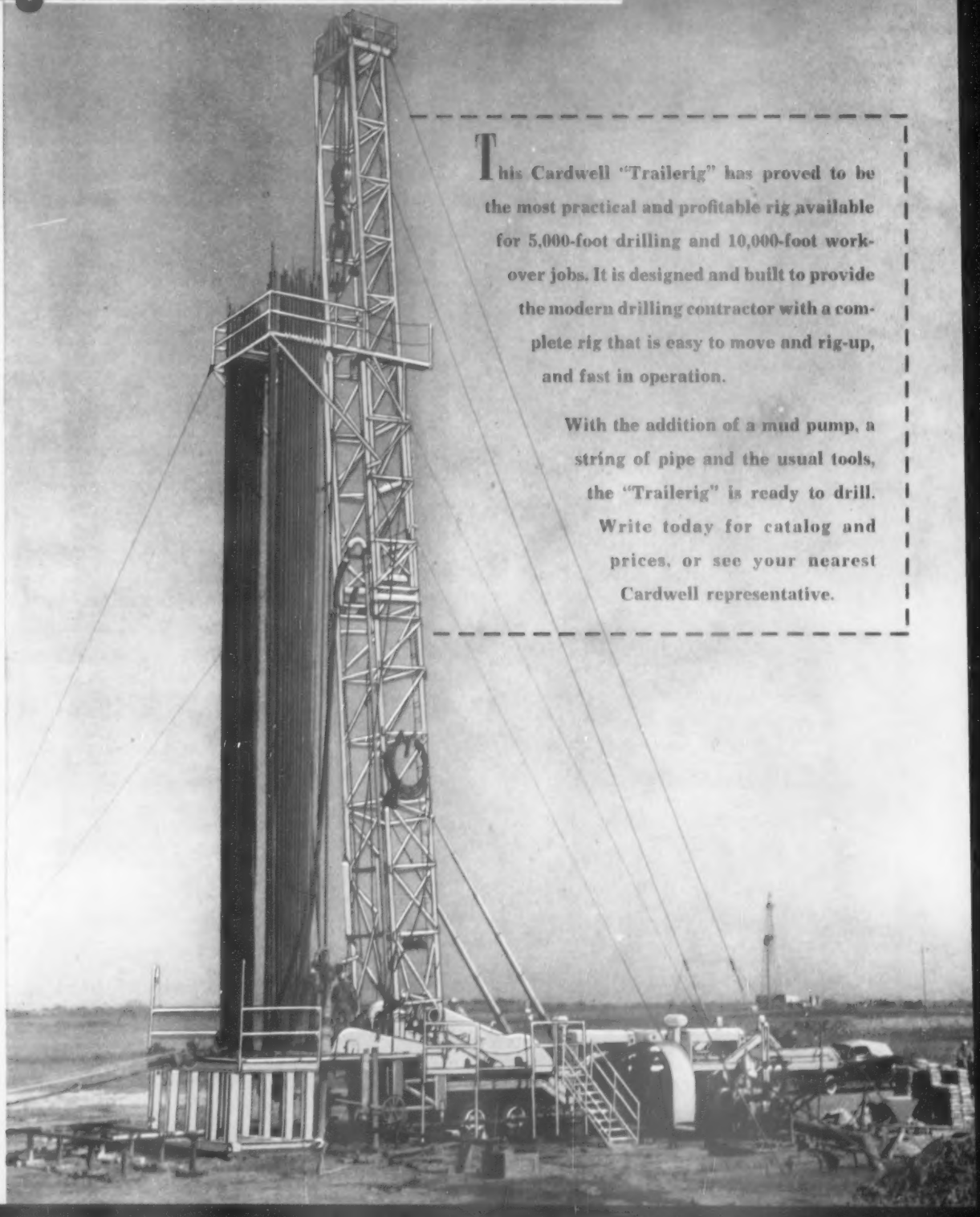
EASIEST WAY TO MAKE ENDS MEET!

CARDWELL "TRAILERIG" IS

...than any comparable rig

1. **Mud Pump Drive is driven by draw work's engines through a Cardwell air friction clutch, which is capable of handling the full horsepower of the rig. Full horsepower of the rig can be used for hoisting and for driving the rotary and pump when drilling. Moving and rigging up is simplified with this built-in mud pump drive.**
2. **"Trailerig" with two engines is within eight feet road width for maximum portability regardless of the overall length of the engines. Placement of engines eliminates eccentric loading and engine overhang.**
3. **Truss-type trailer frame gives exceptional strength and rigidity with minimum weight.**
4. **All rig assemblies are easily accessible.**
5. **Catheads are located ahead of driller for ease of operation, maximum visibility and safety.**
6. **Single chain rotary drive is placed well forward to eliminate secondary chain drives to table.**
7. **One-way rams erect the mast and are supplemented by one-way leg receiving rams which support the mast as it goes over center and push the mast over center when lowering.**
8. **No trailer ramp is needed with the "Trailerig"; this eliminates extra loads and rig-up time.**
9. **Driller has maximum visibility, both to the rotary table and up the mast to the racking platform and crown.**
10. **Ample space is provided under platform for blowout preventers and wellhead connections without using ramps. Complete accessibility from either side.**
11. **Crown sheaves are mounted on Timken bearings for maximum service and life.**
12. **"Trailerig" is a completely unified design combining draw works assembly and telescoping mast with trailer frame.**
13. **Every wearing part of the "Trailerig" is heat-treated for wear resistance and long service life.**
14. **Two-engine drive gives power necessary for modern drilling operations, yet the "Trailerig" does not exceed 8-foot road width.**
15. **Circulating water-cooled brakes are standard equipment. 22″ single Parkersburg Hydromatic brake is available for auxiliary braking.**

15 WAYS BETTER



This Cardwell "Trailerig" has proved to be the most practical and profitable rig available for 5,000-foot drilling and 10,000-foot work-over jobs. It is designed and built to provide the modern drilling contractor with a complete rig that is easy to move and rig-up, and fast in operation.

With the addition of a mud pump, a string of pipe and the usual tools, the "Trailerig" is ready to drill. Write today for catalog and prices, or see your nearest Cardwell representative.

CARDWELL

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THIS TRADE MARK INSURES HIGHEST QUALITY AT LOWEST PRICE

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THERE IS A CARDWELL PARTS STOCK NEAR OR IN EVERY OIL FIELD OF THE WORLD

You can blind

RIGID *lines*

the speedy, cost-cutting way...

WITH

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Visible Shut-off

RIGID

LINE BLIND VALVES

HAMER *Plug Valves*

Thousands of users have proven the easy and immediate operation of HAMER plug valves. Will not stick or freeze.

Hamer "Rigid" Line Blinds solve the problem of blinding pipe lines where no endwise movement of the line is possible. An internal sleeve, actuated by ball-bearing ring gear, takes all movement. Rigid body is unaffected by misalignment or line strains. Enclosed plate slot prevents spillage— stops mess, fire hazard. Blind is easily opened, or closed by one man in one minute.

Send for free catalog.

HAMER VALVES, INC.

2919 Gardenia Avenue

Long Beach 6, California

Representatives throughout to United States

FPC in La Gloria field . . . The Railroad Commission has ordered the operators to cycle gas as a conservation measure. At the same time, the Texas-Illinois Pipeline Co. and the city of Chicago are asking the FPC to make La Gloria field producers deliver more gas.

". . . It all gets down to a question of whether Texas will be in position to conserve this valuable resource or will be forced to deliver it to consumers outside the state . . .

"The Supreme Court decision was based upon an act of Congress, but far transcends the intention of that act . . . The only remedy lies in an amendment to this act . . ."

Editorial in the Dallas Morning News.

"Subsidizing" Imports

"The so-called 'conservation laws' of Texas, Louisiana, and other states are often cited as models for California to follow. I want to point out that Texas and Louisiana are still states with large surplus productivity, which California does not have, and I want to point out further that in both cases the laws are designed to control production by limiting output to market demand, with conservation as an incidental rather than a primary consideration.

"I would also point out that as a result of such laws, production in many states has been curtailed by as much as 50 per cent of M.E.R., largely to make room for imports.

"In other words, American producers having no interest in foreign fields are being forced by their own so-called 'conservation laws' to subsidize, without compensation, foreign imports.

"Do we want this in California?"

Reese H. Taylor, president of Union Oil Co. of California, in an address before a meeting in Bakersfield, Calif., of the San Joaquin Valley Oil Producers Association.

The Iranian Settlement

"Finally . . . is the fact that the Iranian agreement has been worked out on a basis which is regarded as fair and equitable to all parties concerned, including other oil-producing countries in the Middle East and elsewhere . . ."

The Texas Co.'s report to stockholders and employes.

Develop Human Relations

"The growth, vigor, and success of our economic system have been due to changes—changes in technology, products, people, or a new combination of existing factors. While our business system has succeeded in creating technological change, it has not been as

IF YOU PRODUCE, TRANSPORT or REFINE OIL....

Tretolite Company products and services are designed to help you overcome troublesome problems such as

EMULSIFICATION	TretOLite — DEMULSIFIERS	Efficient, assuring a fast break, low cuts; rigidly controlled manufacture to insure uniformity; proved more economical in oil fields everywhere.
WASTE OIL DISPOSAL	TretOLite — WATER DE-OILERS	Remove hydrocarbon stream pollutants with high degree of efficiency; in addition to prevention of nuisance, valuable oil often is salvaged.
CORROSION	KONTOL — CORROSION INHIBITORS	Prevent corrosion in pumping equipment, pipe lines, tankers and refineries. A preventive measure recognized as one of the most effective available.
SCALING	S.P. — SCALE PREVENTIVES	Effective both in field and refinery. Prevent adherence of scale-forming inorganic solids on metal surfaces of production and refining equipment.
SALT FOULING	TretOLite — DESALTING	Efficiently removes salts, solids and other impurities which damage and plug refining equipment, cause frequent shut-downs, high maintenance costs and retarded throughput.
PARAFFIN ACCUMULATION	SOLVO — PARAFFIN REMOVERS	Often useful in preventing accumulation of line-plugging paraffins and asphaltines. Have both solvent and detergent qualities.

For complete information on any or all of these Tretolite Company services, call your Tretolite man.

TRETOLITE COMPANY

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Meet the Widest Range of flow measurement requirements with

AMERICAN-WESTCOTT A-88 ORIFICE METERS

RECORDING · INDICATING
INTEGRATING · TELEMETERING

American A-88 standard mercury type orifice meters for working pressures to 5000 psi. in interchangeable 10, 20, 50, 100 and 200-inch ranges give you complete versatility to meet any flow measurement requirement. Integrating instruments integrate both static and differential pressures giving totalized flow indications and telemetering equipped instruments transmit integrated indications to remote locations.

Recording Meters may be equipped with standard O-150°F. Temperature Elements, as illustrated, giving you every advantage of better temperature measurement with speed, accuracy, simple installation, economy and freedom from maintenance.

Wherever accurate recording and precision measurement are wanted...at high or low flow rates ... at varying temperatures ... there's a job for American® Series A-88 Orifice Meters.

Write for full details now.

AMERICAN-WESTCOTT MERCURY MANOMETERS GIVE YOU ALL THESE ADVANCED DESIGN FEATURES . . . . . .

- Minimum Simple Maintenance—easy access to float lever arm during calibration.
- Highest Accuracy—inherent straight line calibration.
- Interchangeable Ranges—no manifold piping changes.
- Pressure-Tight Teflon-Packed Stuffing Box—nearly frictionless, free from maintenance troubles, never needs lubrication.
- Teflon-Packed Pulsation Dampener—externally adjustable under full line pressure without leakage.
- Dependable Performance—improved check valves give positive shut-off for over-range protection.

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successful in handling the human relations aspects of the changes."

Charles A. Perlitz, Jr., senior vice president and director of Continental Oil Co., in a speech before the sixteenth annual meeting in Austin of the Texas Personnel and Management Association.

CALENDAR OF EVENTS

NOVEMBER

17-18 North Texas Section, American Institute of Mining and Metallurgical Engineers, and Production Committee of the North Texas Oil and Gas Association, symposium on secondary recovery, Wichita Falls, Tex.

18-19 National Association of Corrosion Engineers, fourth annual conference of western region, Hotel Biltmore, Los Angeles.

18-19 Ninth Midwest Quality Control Conference, Society for Quality Control, Dallas.

18-19 Society of Exploration Geophysicists, eighth annual midwestern meeting, Adolphus Hotel, Dallas.

28-Dec. 3 American Society of Mechanical Engineers, Statler Hotel, New York.

DECEMBER

2-4 Interstate Oil Compact Commission, winter meeting, Drake Hotel, Chicago.

2-4 American Chemical Society, Southwest Regional meeting, Fort Worth, Tex.

3 Natural Gasoline Association of America, Panhandle-Plains regional meeting, Herring Hotel, Amarillo, Tex.

12-15 American Institute of Chemical Engineers, annual meeting, Statler Hotel, New York.

1955

JANUARY

17-18 Kansas Oil Men's Association, annual convention, Baker Hotel, Hutchinson, Kans.

17-19 Pipe Line Contractors Association, annual convention, Hotel Statler, Los Angeles.

26-28 Symposium on instrumentation for process industries, A. & M. College of Texas, College Station, Tex.

27-28 American Chemical Society, symposium on hydrocarbon chemistry, Rice Hotel, Houston.

FEBRUARY

13-17 American Institute of Mining and Metallurgical Engineers, annual meeting, Conrad Hilton Hotel, Chicago.

13-18 A.S.T.M. Committee D-2 on Petroleum Products and Lubricants, Rice Hotel, Houston.

14-16 Rocky Mountain section of A.A.P.G., annual regional convention, Billings, Mont.

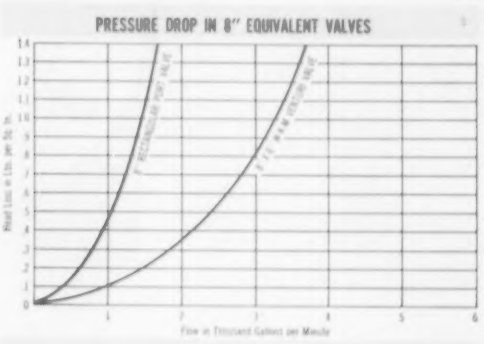
16-18 National Association of Corrosion Engineers, sixth annual short course for pipeliners, Mayo Hotel, Tulsa.

25 National Gasoline Association of America, Permian basin regional meeting, Scharbauer Hotel, Midland, Tex.

AN ENGINEER LOOKS AT W-K-M VALVES

ON PRESSURE DROP

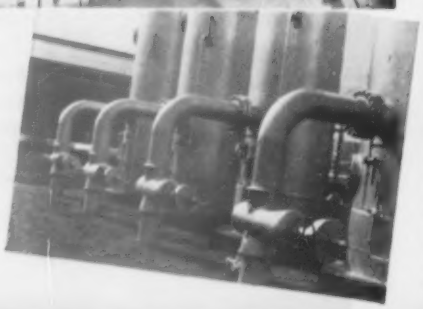
IN
W-K-M ROUND OPENING
VENTURI VALVES
AND
RECTANGULAR OPENING
PLUG VALVES



You get 21% **less** pressure drop in W-K-M Venturi Valves than in rectangular opening plug valves as shown by the pressure drop chart at right. **And,** in equivalent sizes, W-K-M Venturis cost the same or less than plug valves.

You're way ahead when you specify W-K-M — not only do you get far greater transmission efficiency, but you get leverlock operation, positive seal on both sides, spot lubrication at seat, and other advantages, all of which have made W-K-M Valves first on the world's major pipelines.

W-K-M Valves



W-K-M MANUFACTURING COMPANY, INC.

A SUBSIDIARY OF A.C.F. INDUSTRIES INCORPORATED

P. O. Box 2117, Houston 1, Texas Los Angeles, California

Export Office: 45 Rockefeller Plaza, New York, N. Y.

2 BIG REASONS WHY MAJOR PIPELINES

Low Maintenance

Bingham Pipeline Pumps are of "Double Volute" design, insuring perfect radial balance of the rotating element. This "Hydraulic Radial Balance" eliminates the unequal pressures on the shaft that are the primary cause of wear and maintenance in conventional pumps.

"Double Volute" design also makes possible a more compact multi-stage design, resulting in reduced load on case boltings. Dual-stage cross-overs, *possible only* with "Double Volute" construction, reduce the axial space between stages, effectively decreasing the overall length of the pump shaft and the span between main bearings. All this adds up to *low maintenance* and trouble-free service.

Long Seal Life . . . "Hydraulic Radial Balance" eliminates shaft deflection, permitting mechanical seals to establish and maintain a uniform "Track" between the contacting faces.

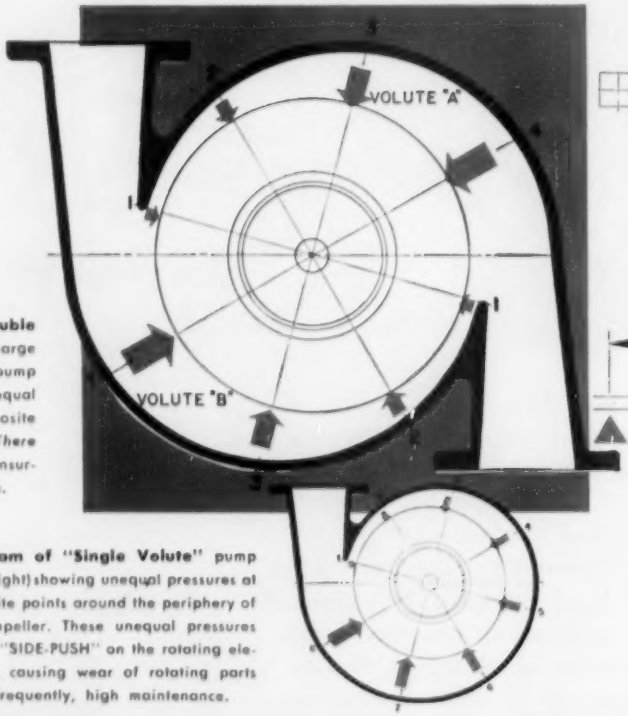
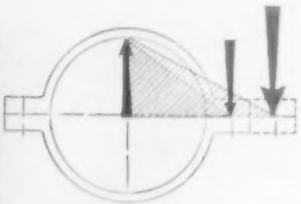
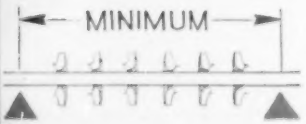


Diagram of a "Double Volute" double discharge case of a multi-stage pump (right) showing the equal pressure on the opposite sides of impeller. *There is no* "SIDE-PUSH", insuring low maintenance.



Greater Compactness in multi-stage "Double Volute" design reduces load on case bolting.



A Wide Range of Operating Speeds Is Possible because "Double Volute" construction reduces the overall length of pump shaft and the span between the main bearings.

Diagram of "Single Volute" pump case (right) showing unequal pressures at opposite points around the periphery of the impeller. These unequal pressures cause "SIDE-PUSH" on the rotating elements, causing wear of rotating parts and, frequently, high maintenance.

NEW MAJOR PIPELINES *recently placed into operation equipped with Bingham "Double Volute" pumps:*

Interstate's Southern Main Pipeline
Kaneb Pipe Line
Mackinac Pipe Line
Magnolia's Reinggold Pipeline
Trans-Mountain Pipeline
Trans-Northern Pipeline
Tuscarora Pipe Line
Standard Oil of Indiana Pipelines:
1. **Dubuque—Moorhead Pipeline**
2. **Mandan—Moorhead Pipeline**
3. **Whiting—River Rogue Pipeline**

NEW MAJOR PIPELINES *under construction being equipped with Bingham "Double Volute" pumps:*

Cherokee Pipeline
Great Lakes Pipeline
Interprovincial Pipeline
Lakehead Pipeline
Minnesota Pipeline
Oklahoma-Mississippi River Pipeline
Brazilian Government Pipeline

THESE ARE ONLY A FEW OF THE MAJOR PIPELINES BEING SERVED BY BINGHAM PUMPS TODAY

SELECT *Bingham*

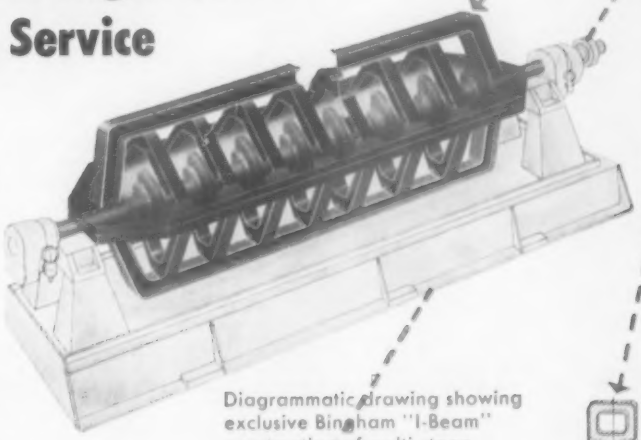
"DOUBLE VOLUTE" PUMPS

I

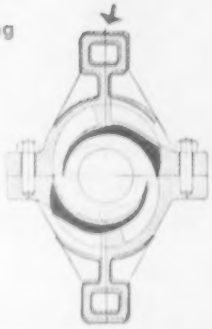
2 **Assured Case Strength for High-Pressure Service**

Integral cross-overs in Bingham "Double Volute" multi-stage pumps produce casings of maximum strength for high pressure service because each cross-over is cast integrally with its half of the pump casing, and thereby becomes a structural member of Bingham's "I-Beam Truss Construction".

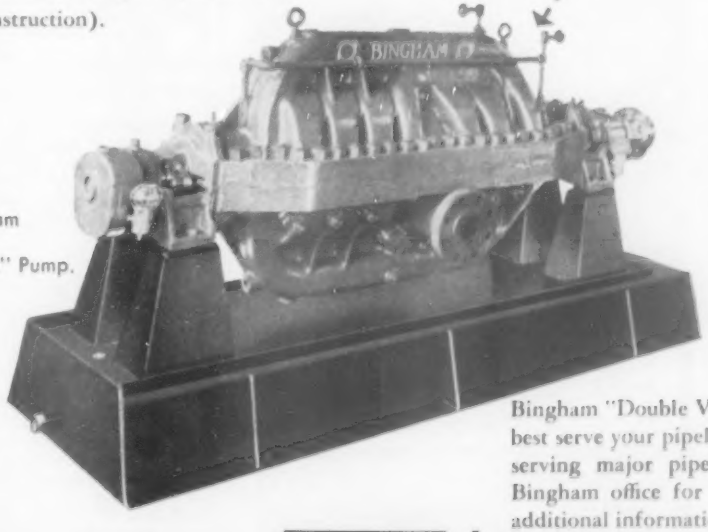
This feature, found only in Bingham pumps, increases the strength of the pump casing to such an extent that it can safely withstand pressures up to 2000 psi with standard construction (higher pressures with special construction).



Diagrammatic drawing showing exclusive Bingham "I-Beam" construction of multi-stage "Double Volute" pump.



A transverse cross-section of Bingham "Double Volute" Multi-Stage Pumps, showing identical cross-overs cast integrally with the upper and lower halves of the pump casing.



Typical Bingham Multi-Stage "Double Volute" Pump.

Bingham "Double Volute" Multi-Stage Pumps will best serve your pipeline operations, as they are now serving major pipelines. Write to your nearest Bingham office for "Double Volute" Bulletin or additional information.

Bingham SINCE 1921

DOUBLE VOLUTE PUMPS RADIAL BALANCE

BINGHAM PUMP COMPANY

General Offices: **2800 N.W. Front Avenue, Portland 10, Oregon**

Factories: **Portland, Ore. • Vancouver, B.C., Canada**

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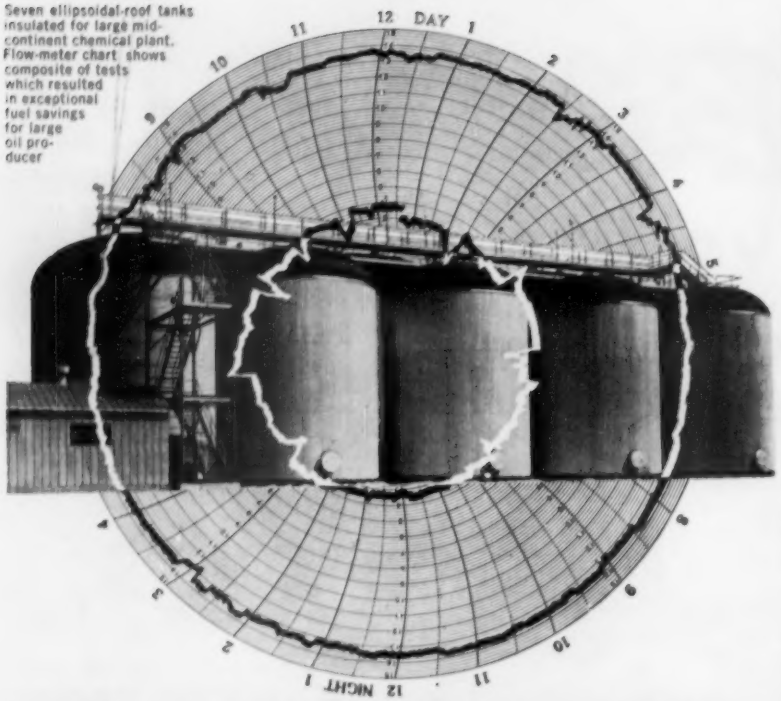
Seven ellipsoidal-roof tanks insulated for large mid-continent chemical plant. Flow-meter chart shows composite of tests which resulted in exceptional fuel savings for large oil producer



"FUEL SAVINGS TRULY AMAZING"

says top executive recommending new tank insulation method

PAYS OUT COSTS IN 4 TO 18 MONTHS

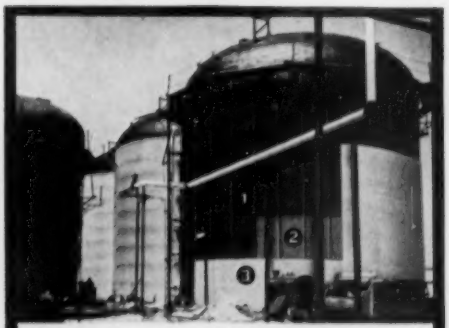
We quote from a letter one big oil company wrote another about the Nicholson & Galloway 3-stage Tank Insulation Method:

"We have had seven of our larger asphalt storage tanks insulated by their method of aluminum cladding... over a period of two years. The results in fuel savings have been truly amazing and far beyond our Engineering Department's expectations. The work has been carefully supervised and handled and we can recommend this firm and their methods most highly to you."

For details on cost of insulating your tank or vessel send for Pamphlet O.

TANK INSULATORS INC
426-428 EAST 110TH STREET
NEW YORK 29 N.Y.

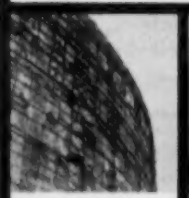
Phone ENright 9-5004



Stage 1 Tank or vessel surfaces are divided into areas bounded vertically by channel sections

Stage 2 Insulation of any specification or thickness is snugly installed within these areas

Stage 3 .024 Corrugated Aluminum Sheathing, Asbestos Transite, Monel or Stainless Steel then covers and protects insulation for life of tank.



Conventional insulation shreds and falls loose when weather - proofing fails and metal bands expand.

Three asphalt tanks 50-foot diameter 48-foot high insulated for large southwestern oil refinery.

MARCH

- **4** Southern Gas Association, transmission management conference, Shamrock Hotel, Houston.
- **7-11** National Association of Corrosion Engineers, Palmer House, Chicago.
- **9-11** American Petroleum Institute, Division of Production, Southwestern spring meeting, Jung Hotel, New Orleans.
- **17-18** Southern Gas Association, Distribution Management Conference, Jung Hotel, New Orleans.
- **24-25** American Gas Association, gas supply, transmission, and storage conference, Wm. Penn Hotel, Pittsburgh.
- **27-29** Texas Independent Producers and Royalty Owners Association, ninth annual meeting, Hotel Texas, Fort Worth.

APRIL

- **13-15** Natural Gasoline Association of America, annual convention, Baker and Adolphus hotels, Dallas.
- **13-15** American Society of Lubrication Engineers, tenth annual meeting, Hotel Sherman, Chicago.
- **19-21** Southwestern Gas Measurement Short Course, North Campus, University of Oklahoma, Norman, Okla.

MAY

- **1-4** Liquefied Petroleum Gas Association, annual convention, Conrad Hilton Hotel, Chicago.
- **1-4** American Institute of Chemical Engineers, Shamrock Hotel, Houston.
- **9-10** American Gas Association, Gas Supply, Transmission and Storage Conference, Hotel William Penn, Pittsburgh.
- **9-12** American Petroleum Institute, Division of Refining, midyear meeting, Jefferson Hotel, St. Louis.
- **14-22** World Wide Chemical Plant and Equipment Exposition and Congress, Frankfurt Germany.
- **16-18** American Petroleum Institute, Division of Transportation, products pipeline conference, Edgewater Beach Hotel, Chicago.
- **16-18** Southern Gas Association, New Orleans.
- **23-25** American Petroleum Institute, Division of Marketing, midyear meeting, Chase and Park Plaza hotels, St. Louis.
- **26-27** Kentucky Oil and Gas Association, annual meeting, Lafayette Hotel, Lexington.

MAY 30-June 1 Chemical Institute of Canada, thirty-eighth annual conference and exhibition, Quebec City, Que.

JUNE

- **5-9** Canadian Gas Association, annual meeting, Sheraton-Brock Hotel, Niagara Falls, Ont.
- **6-10** American Petroleum Institute, Division of Production, midyear committee conference, Brown Palace Hotel, Denver.
- **6-15** Fourth World Petroleum Congress, Rome, Italy.
- **9-10** Natural Gas and Petroleum Association of Canada, Royal Connaught Hotel, Hamilton, Ont.
- **9-10** Pennsylvania Grade Crude Oil Association, annual meeting, Hotel William Penn, Pittsburgh.
- **16-18** Interstate Oil Compact Commission, Denver.

JUNE 28-JULY 1— American Society for Testing Materials, Chalfonte-Hadden Hall, Atlantic City, N. J.

QO Furfural is the principal extractive distillation agent used in the purification of butylenes and butadiene. Furfural alters the relative volatility of the C_4 hydrocarbons and thus facilitates the low cost separation of these important synthetic rubber raw materials.

Furfural's stability and ease of recovery keep losses at a low level; recent estimates place them at 0.005% of the furfural circulated. This low loss when combined with furfural's low cost results in a very economical separation.

Furfural is available to industry in large amounts. Its selectivity, stability, ease of recovery and availability led to its selection for use in plants built during World War II to alleviate the country's critical rubber shortage. Ten years of operating experience have shown the wisdom of that choice.

Write for information on furfural extractive distillation and Bulletin 203 listing physical properties of furfural.

The Quaker Oats Company **CHEMICALS DEPT.**

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In Europe: Quaker Oats-Graanproducten N. V., Rotterdam, The Netherlands; Quaker Oats (France) S. A., 3, Rue Pillet-Will, Paris IX, France
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Safest Storage for Your "Liquid Assets"

Performance records prove that Wiggins Double Pontoon Floating Roofs soon pay for themselves in liquid conserved. Only Wiggins Double Pontoon Floating Roofs have every important feature for maximum conservation . . . safest operation . . . low-cost maintenance.

Triple Seal increases conservation savings and adds extra safety.

Multiple gas-tight pontoon compartments increase safety, strength and buoyancy.

Simplified design gives strength with minimum trussing, making inspection and maintenance easy.

Complete, clean drainage reduces corrosion problems.

Get the full story on the General American-Wiggins system of petroleum liquid conservation by writing us on your letterhead for the new Wiggins Manual WP-14.

Wiggins Double Pontoon Floating Roofs, Dry Seal Gasholders, Lifter Roofs, Cone Roofs

GENERAL AMERICAN TRANSPORTATION CORPORATION

135 SOUTH LA SALLE STREET · CHICAGO 90, ILLINOIS

THE OIL AND GAS
JOURNAL
TULSA, OKLAHOMA

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JOURNALLY Speaking

Mythical Miss

IN a commendable effort to boost the sale of fuel oil, the A.P.I. has put out a little leaflet taking some liberties with Greek mythology and implying that Pandora's iron box was the beginning of stoves and furnaces through which the oil industry is now enabled to serve the world's heating needs.

Okay if it sells oil burners, but we hope the oil-buying public is not well versed in the classics. For as we recall that tale, the famous box brought to earth by that beguiling vixen Pandora contained nothing but troubles for the male segment of the so-called human race. It is to be hoped that householders don't get the idea that they are opening a Pandora's box of troubles by switching to oil heat. The oil business has enough troubles of its own without borrowing any from this old Greek charmer.

Peace, It's Wonderful

AN astonishing attitude toward oil is brought back from Europe by a California geologist who recently made an extensive tour of the Continent. In France, Italy, Holland, and Germany he found active exploration under way and high interest in the prospects for oil development.

But in Switzerland, where he noted some geological evidence of the possible occurrence of oil, he found not only distinterest but even a definitely negative attitude. The explanation given him was that if Switzerland should develop a prosperous oil industry, the little Alpine nation would become such a tempting prize for an aggressor that it would not be able to maintain its centuries-old neutrality come the next war.

Now that's a thought to ponder. Here in the United States our Government has deliberately fostered the creation of an excess producing capacity and encouraged our nationals to develop foreign supplies, all in the name of national defense. Most other nations likewise have the view that possession of big reserves of oil and a prosperous petroleum industry are an insurance of peace and a deterrent to an aggressor.

On the other hand, here is little Switzerland which, not owning a barrel of oil, has kept at peace while the biggest wars of history raged all around her. Do the Swiss really have something there? Is the way to avoid war to be a "have-not" nation? Should we emulate this peace-at-any-price policy and cut down our oil industry to the point where no aggressor would bother to give us a second look?

Let's not. That philosophy has as many holes in it as a Swiss cheese, however much the Swiss may like it. Having been operating for 150 years on the theory that abundance insures strength and strength insures peace, let's keep right on fostering a strong, vigorous oil industry in these United States.

Notes From All Over

A TURK is trying to get the U. S. Government to interest American capital in his "2-hp. perpetual-motion machine which functions like an oil engine" . . . probably got the idea from seeing American oil men operating in Turkey. Two oil wells in California have been donated to a fund to fight cancer . . . haven't heard of any cigaret factories being dedicated to that project. Exploration activities in Florida revive legends of a mystery gusher brought in during World War I . . . said to have splashed oil over a square mile of timberland and then was capped and hushed up . . . Chicago syndicate reportedly paid $1,000,000 for the well but never could find the site . . . it's probably in the same township with Ponce de Leon's Fountain of Youth. Brown bands on "wooly bear" caterpillars in New England foretell a mild winter . . . bad for fuel-oil sales . . . but in the Midwest the corn has tighter husks and the trees thicker bark . . . better fill your tanks in that area.

—Henry D. Ralph.

- A SINGLE SET-UP permits perforating, and setting of BAKER Packer, Bridge Plug of Cement Retainer.
- YOU SAVE VALUABLE TIME over setting on tubing or drill pipe.
- ACCURATE, CORRELATED SETTING DEPTH is simple with wire line measurements.
- PREMATURE SETTING IS MINIMIZED through the use of accessory equipment.
- WIRE LINE SERVICE COMPANIES can set THESE DEVICES for BEST RESULTS.
- MORE POSITIVE SETTING with exclusive BAKER Setting Mechanism.
- YOU SAVE WEAR AND TEAR on tubing or drill pipe.

7 REASONS WHY...

Wire Line Setting

of these BAKER Tools Saves Time, Money and Trouble

Baker Retainer Production Packer Product No. 415-D

Baker Cement Retainer Product No. 400

Baker Wire Line Bridge Plug Product No. 400-N

FOR HELPFUL SUGGESTIONS as to how Baker Retainer Production Packers, Baker Wire Line Bridge Plugs and Baker Cement Retainers can make *your* operations more profitable, contact the Baker representative in your area. His knowledge is based upon applications in nearby wells, and he can give you *specific recommendations* to help solve *your* problems.

1. BAKER RETAINER PRODUCTION PACKERS *virtually become a part of the casing string* when set. The tubing string can be run through the packer, sealed off in the bore of the packer, but is readily removed *without disturbing the packer.* Down-hole tools are run through this "free" tubing string for operations below. The *entire packer can be drilled out readily.* They are easily installed for Single- or Dual-Zone Production; for Testing, Acidizing, Re-pressuring, Cementing, and other applications.

2. BAKER WIRE LINE BRIDGE PLUGS *set positively, hold against any pressure safe for the casing,* (from above or below) *and are easily and quickly drilled up.* Made of Cast Iron or of Magnesium to meet varying conditions imposed by well fluids or length of installation time.

3. BAKER CEMENT RETAINERS are constantly being improved and are always reliable for all types of squeeze or remedial cementing, testing, plugging-off, and similar applications. They are easy to run—pack off positively—hold any pressure safe for the casing. Readily used as casing bridge plugs.

Contact your choice of these leading service organizations who are licensed to use the Baker Wire Line Setting Mechanism and other accessories for setting these Baker Tools . . .

The Ford Alexander Corporation	Husky Guns, Inc.	Ram-Guns, Inc.
Bird Well Surveys	Lane-Wells Company	Schlumberger Well Surveying Corp.
BJ Service, Inc.	McCullough Tool Company	Welex Jet Services, Inc.
The Dia-Log Company	Perforating Guns Atlas Corp.	The Western Company
Dowell Incorporated		

call **BAKER**

OIL TOOLS, INC.

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Mixed up but far from crazy

A COMMON observation among those attending the A.P.I. annual meeting in Chicago was that the titles of many of the papers seemed to have little relationship to the subjects of the sessions where they were given.

"It's a crazy, mixed-up program if I ever saw one," remarked a bewildered delegate.

Refining sessions heard talks on foreign economic policy and weather forecasting. Marketers heard about the troubles of natural-gas producers. Pipeliners heard talks on integration of the oil industry and developing good will among oil consumers. Production men heard about petrochemicals, Iranian politics, and how to develop top management leaders. And so on.

MIXED UP THE PROGRAM CERTAINLY WAS, but it was far from crazy. It was planned that way. And the mixture makes sense.

It is a recognition that petroleum, for all its diverse ramifications, is a single industry and will stand or fall together; that more attention must be given to interdivision communications; and that all must learn to appreciate the problems of other branches of the industry.

It is a recognition that an industry is only as strong as its leadership; that leadership must come up through the ranks; and that men having, or destined for, managerial responsibilities must have a broad background and a forward outlook.

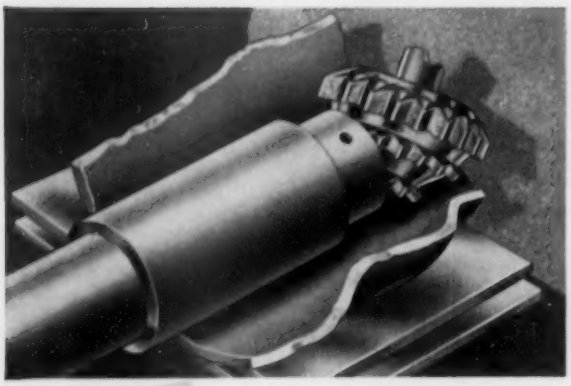
It is a recognition that technological progress, important as that is, is not the industry's sole need; that sound management is needed in applying new developments if the industry and the public are to be served best; that all who work in oil must help make friends for and understanding of the industry if it is to be kept free from hamstringing political interference.

SPECIALISTS WE MUST HAVE, but not the kind of specialists who learn more and more about less and less. And as our technology becomes increasingly complicated we must make extra effort to maintain a broad horizon.

So it was good that the A.P.I. program was such a mixture. Framed to give each division at least a glimpse of the problems of others—problems which really face the whole industry and which must be solved in a way satisfactory to all if they are to be settled right.

For if the petroleum industry permits itself to get compartmented into occupational or regional segments or twistoffs, if it fails to keep itself a single integrated industry with a "one for all, all for one" attitude, then it will really become a crazy, mixed-up industry for certain.

Now the Welex FORMATION FRACTURING TOOL Gives You the POWER You Need For EFFECTIVE Down-Hole Junk Shots



BEFORE *the muzzle of the Formation Fracturing Tool is placed against one cone of a three-cone rock bit simulating a common well condition.*

AFTER *shown immediately after firing only one shot with the powerful new Welex Tool. All that remains of the cone are small, easily-removed particles.*

Avoid days of expensive fishing, drilling, or milling by using the Welex Formation Fracturing Tool on your next junk job. It gives you hundreds of thousands of foot pounds of energy that you can direct *exactly* where you want it — right at your obstruction. This remarkable new tool is placed right on the junk, plug, or packer that you want removed. It delivers its full force in a hammer blow of a powerful missile traveling at a muzzle velocity of over 4,000 feet per second.

Your obstruction is quickly removed at a minimum of time and cost. The resulting junk is small and easily handled by a sand pump or other standard clean out equipment. And, as all the power of the Formation Fracturing Tool is directed straight down the well bore, there is little or no damage to the wall casing. Call for the Welex Formation Fracturing Tool for your next junk shot.

Also, use the Formation Fracturing Tool whenever you have production troubles in tight formations. Fired with a directional channel, the tool's missile penetrates *feet* into the formation with extensive fissuring. Combined with a large diameter entrance hole, it's a "must" before any acidizing or pressure fracturing job where you want to insure that your fluid gets back into the formation.

Call Welex and be Sure!

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THIS WEEK . . . . . IN THE NEWS

CAPACITY CROWDS were common at the American Petroleum Institute meeting in Chicago last week as a record throng of 6,550 oil men assembled in dozens of sessions devoted to specific problems affecting the industry. This is a scene in the Grand Ballroom of the Conrad Hilton Hotel as G. Stewart Brown, Standard Oil Co. of California, reported on the public relations program of the Oil Industry Information Committee. Next year's meeting, as previously announced, will be in San Francisco, and the 1956 convention will return to Chicago. The Windy City also will be the scene of the 1957 convention, it was disclosed last week.

A.P.I.—The general outlook for the industry is good, but the long-range picture is blurred by many questions. . . . ¶Foremost in the minds of most of those attending the thirty-fourth annual meeting at Chicago were the twin problems of imports versus domestic production and federal control of natural-gas producers' prices. . . . ¶FPC chairman says his agency didn't want price-fixing job and asks for industry help in solving problems. . . . ¶I.P.A.A. president serves notice of battle for legislative relief from imports. . . . He is answered by major importer who urges patience and restraint. . . .

PIPELINES—Pembina Pipe Line Co., Ltd., completes 16-in. crude line from Pembina field. . . . Line expected to stimulate development of field and cut transportation costs. . . . ¶L.P.G. line planned from Tioga to Winnipeg to move North Dakota butane and propane to Canada. . . . Details have not been completed. . . . ¶Western and Arapahoe pipelines, two Rocky Mountain crude outlets, are being tested. . . . ¶Cheyenne Valley Pipe Line Co. revises plans for Wyoming crude line. . . . Length extended from 58 to 118 miles. . . . ¶Wyoming-Nebraska products line being filled. . . .

OFFSHORE—Spirited bidding marked Bureau of Land Management's leasing of 19 tracts in Texas Continental Shelf. . . . Magnolia paid $2,209 per acre for 1,440-acre tract, which was almost twice as much as the top acreage price of $1,220 paid at recent leasing of Louisiana shelf lands. . . . Standard of Texas acquired 6 of the 19 leases with bids totaling approximately $10 million. . . . Stanotex also made highest bid, $4,565,251. . . . ¶Acting comptroller general recommends that Kerr-McGee Oil Industries' mistaken bids for Louisiana shelf tracts be canceled and almost $3 million "earnest money" be returned. . . . Interior official has said the department will follow comptroller's recommendation. . . .

REFINING—South Dakota will reenter the refining industry with a 3,000-bbl. daily refinery planned by the newly organized Great Plains Refinery & Development Co. . . . New plant will be built at Rapid City. . . . Three small refineries in state now shut down. . . . ¶Husky Oil & Refining buys 2,000-bbl. refinery at Moose Jaw, Sask. . . .

NATURAL GAS—Stanolind and Ohio Oil file suits that will give FPC's Order 174-A its first court tests. . . . Stanolind seeks injunction against Government while Ohio Oil's suit is against the commission, seeking review and stay of order. . . . ¶Supreme Court will decide whether Oklahoma has authority to establish minimum price for natural gas from Guymon-Hugoton field. . . . Oklahoma's highest court has upheld state order setting minimum at 9.8262 cents per M.c.f. . . . ¶Toronto making switch from manufactured to natural gas. . . .

Industry outlook good, but . . .

"Ifs" Blur Long-Range Picture

CHICAGO.—The outlook for the oil business is moderately good for next year—but a lot of "ifs" cloud the long-range picture.

That's the temper of the industry as reflected at the thirty-fourth annual meeting of the American Petroleum Institute here November 8-11.

Statistically, the general expectation is that:

. . . **Demand** will increase something like 4 or 5 per cent in 1955.

. . . **Burdensome inventories** will probably be worked down.

. . . **Imports** will continue to rise at a greater rate than domestic production.

. . . **Spending** by United States operators will continue at about current levels.

. . . **Momentum of expansion** and competition will bring further expansions in capacity to produce, refine, and transport oil beyond actual needs for perhaps several years.

But factors which can't be measured statistically worry the industry and make it difficult to foresee what conditions will be like a few years hence.

Topping the list of such unpredictables are foreign developments affecting both production and consumption of oil abroad, the burden of carrying excess domestic capacity, federal regulation of natural-gas production, potential government threats to disintegrate the oil industry and to impose end-use controls, and an apparent trend toward decreased gasoline consumption per vehicle due to highway congestion and other causes.

Economic outlook . . . Two economic analysts outside the oil industry predicted that business generally will improve moderately during the coming year.

"Recovery is not likely to be spectacular during 1955," said Edwin P. George, economist of Dun & Bradstreet, Inc. "I see no particular reason to expect a sharp recovery in 1956. . . . A rise in gross national product should be setting in about now and culminating at a point nearly $11 billions higher by the end of next year. . . . It's to be a year without much character . . . not declining moderately, not merely stable, but rising. . . . We should have approximately full employment by the fourth quarter. . . . A real boom seems unlikely."

"The economy will grow 4 per cent in 1955," predicted Allyn P. Evans, president of Lionel D. Edie & Co. "The increase will be built upon a solid economic foundation . . . (principally) increase in standard of living and increase in population. . . ."

A specific 1955 forecast for oil was made by John W. Boatwright, assistant general manager, supply and transportation department, Standard Oil Co. (Ind.):

Domestic demand up 5.3 per cent, exports down 18.6 per cent, total demand up 4.3 per cent, domestic production up 4.3 per cent, crude imports up 7.2 per cent, products imports up 2 per cent, total new supply up 4.4 per cent.

Talk about weather . . . In his annual report Frank M. Porter, president of the Institute, warned the industry against again going into the spring with excess inventories of light products. Given a normal winter, he said, demand for heating oil should increase 8 per cent, but we have had a series of five winters warmer than normal.

A somewhat optimistic note was injected by Fred Van Covern, A.P.I. economist, who noted that the weather so far this fall has been colder than normal in much of the country and weather forecasts indicate that heating oils will be in heavy demand during the coming weeks.

The fourth quarter of this year may surprise many in the industry in the increase in demand, he ventured, and this gives hope that inventories of refined products will be worked off during the winter and the industry will not face the spring with such burdensome stocks as it had last spring.

Forecasting the weather has always been a prime problem for the oil industry, but not much hope of an immediate solution was offered by the chief of the U. S. Weather Bureau, Dr. Francis W. Reichelderfer. He described for the oil men the various kinds of forecasts now being made by both government and private forecasting serv-

LARGEST CROWD ever to attend an oil meeting jammed Chicago last week for the annual A.P.I. convention. This year's registration total was 6,550, compared with the previous record of 6,393 set at the 1952 convention. Part of the huge crowd is shown above at the registration desk in the Conrad Hilton Hotel.

ices and outlined the progress being made toward understanding the complex interrelation of forces which control the weather, but he was not optimistic that the oil industry would have completely dependable detailed forecasts of temperature conditions any time in the near future.

The big uncertainty . . . The uncertainty that looms largest in the minds of most oil men is what John Boatwright called the "cushion concept"—the need, for defense purposes, of producing and other capacity beyond the needs of the market.

The kind of expansion that comes from competition under normal conditions has given way, since the Korean crisis, to an expansion of producing and refining capacity for which there is no strictly economic justification.

A. W. THOMPSON
Production

J. G. JORDAN
Marketing

E. B. McCONNELL
Refining

Three New Vice Presidents

CHICAGO.—Three divisions of the A.P.I. elected new vice presidents here last week while the rest of the top officers remained the same.

Newly elected were: A. W. Thompson, vice president of production; E. B. McConnell, vice president of refining; and J. G. Jordan, vice president of marketing.

P. C. Spencer, Sinclair Oil Corp., was retained as board chairman, and Frank M. Porter, Fain-Porter Drilling Co., Oklahoma City, was reelected president.

Other top officers reelected include: Charles S. Jones, Richfield Oil Corp., vice president of transportation; B. Brewster Jennings, Socony-Vacuum Oil Co., treasurer; and Lacey Walker, A.P.I. secretary.

Paul Kayser, president of El Paso Natural Gas Co., and Roy J. Thompson, Apex Motor Fuel Co., Chicago, were elected to the board of directors for a 2-year term.

Other new directors elected by the membership for a 1-year term are: Rainey Elliott, Jones & Laughlin Supply Co., Tulsa; H. B. Gernert, Trigood Oil Co., Casper, Wyo.; R. S. McFarland, Seaboard Oil Co., Dallas; A. W. McKinney, National Supply Co., Pittsburgh; and Jordan, the newly elected vice president.

J. Porter Langfitt, Pure Oil Co., Chicago, was elected to succeed L. S. Wescoat.

Thompson, a 1951 recipient of an A.P.I. "certificate of appreciation," is president of Thompson-Carr, Inc., Houston, and a former member of A.P.I. board of directors. He began his petroleum career in 1919 in the engineering department of The Texas Co. at Port Arthur, Tex.

In addition to his vice presidency, Thompson also serves on A.P.I. production division's central committee, A.P.I. central committee on vocational training, and A.P.I. rotary drilling equipment committee. He has also served two terms as president of American Association of Oilwell Drilling Contractors.

McConnell is vice president in charge of manufacturing and a member of the board of directors of Standard Oil Co. (Ohio). He began his fulltime petroleum career in 1923 with Standard Oil Co. (N.J.). In 1927 he was sent to Cleveland to help Sohio set up two new cracking coils at its refinery there. In 1928 he accepted the position of assistant to the vice president in charge of manufacturing of Sohio, and in 1945 he was made general manager of the manufacturing department. He was elected a vice president and director in September 1946.

Jordan, vice president in charge of marketing for Shell, began his industry career in 1925 as a clerk in Shell's St. Louis office.

He was named division manager at Cleveland in 1932. He remained there until 1943 when he was named retail sales manager of Pacific Coast area. In 1947 he was appointed vice president in charge of Pacific Coast marketing, and in 1949 he moved to New York to assume his present position.

MORE STANDARDIZATION of refinery equipment is one of the goals of this industrious group headed by Russell H. Venn, Humble Oil & Refining Co., Houston. Picture was taken at a meeting of the Committee on Refinery Equipment.

"Producing capacity is expanding steadily . . ."

"Drilling . . . checked when pocketbook really feels it . . ."

"Domestic producers are unhappy" . . . with imports . . .

A.P.I. President Meets the Press

CHICAGO.—The momentum of drilling is carrying American oil producers toward expenditures of between $2½ to $3 billions for exploration and development this year in spite of the fact that less crude is being produced this year than last.

Frank Porter, A.P.I. president, said the trend is going to be stopped only by a "pocketbook that feels it" because operators can't keep spending more for exploration while their income from production is shrinking.

A lot of money is going to be spent in "expensive places," Porter said, and this may detract from exploration in other places, in a reference to the upswing in offshore exploration.

Porter declared that domestic producing capacity is expanding steadily and that next spring's estimates of reserves probably will show that 1954 was a good year for finding new oil as well as showing advances in greater potential recovery from known fields.

Reserve producing capacity will be in the neighborhood of 1,600,000 to 1,700,000 bbl. daily, he said.

Skirting the subject of imports gingerly, the genial association president remarked that domestic producers are "unhappy" at having their output cut back continually while there is only "token" reductions in oil imports.

Replying to a reporter's question, Porter said he still regards the "climate for business" as better than it was before the change in the national administration 2 years ago. He conceded that the industry has a number of knotty problems to solve and listed the governmental regulation of natural gas and reduced use of automotive gasoline because of congested highways—or other reasons—as prime problems.

He said legislation to ease the gas regulation problem won't be easy, and pointed to television and air-conditioning of homes as factors in reduced automobile travel.

"Depletion is more necessary now than ever before," Porter said, "and its going to take some positive action from industry to put the story across."

"Pardon me, my cigar needs a light . . ."

"Corrective gas legislation won't be easy . . ."

"Climate for business still better . . . after 2 years."

PUBLIC RELATIONS will continue to play a major role in the A.P.I. program during 1955. W. R. Huber (left), Gulf Oil Corp., Pittsburgh, is new chairman of the Oil Industry Information Committee, succeeding G. Stewart Brown, Standard Oil Co. of California, shown at the rostrum. The industry's public relations program was praised by Gov. Robert F. Kennon of Louisiana (second from left) and H. S. M. Burns, president of Shell Oil Co.

O.I.I.C. Sets Aims

Committee chided for being modest in demand for funds; all branches urged to take part in educating the oil buyer

CHICAGO. — The public relations program of the oil industry has been scattering its shots, but in the future it will concentrate on specific targets.

The plans were outlined for the A.P.I. by G. Stewart Brown, head of public relations for the Standard Oil Co. of California and retiring chairman of the Oil Industry Information Committee. The O.I.I.C. has been in charge of the operating phases of the industry's public relations program, since its inception 8 years ago.

Brown said that the committee has been too modest in asking for financial and manpower aid from the oil business. He said in the future greater stress will be placed on securing more participation from all divisions and all operating phases of the industry. In the past the work of the committee has been largely carried on by representatives of the marketing branch.

Program approved . . . The 1955 program was later approved by the A.P.I. board of directors. The budget totals $3,075,000, a decrease of about 5 per cent from the 1954 budget. Most of the decrease is in a reduction in advertising from $1,504,740 in 1954 to $1,250,000 in 1955.

Other major items include: education and youth, $122,500; film projects, $250,000; Oil Progress Week, $75,000; field organization, $782,448 and national organization, $295,353.

The committee did not recommend the much discussed proposal for a national television program at this time. The cost of such a program would mean doubling the present budget.

What's already been done . . . Brown and H. S. M. Burns, Shell Oil Co. president who represents the A.P.I. board of directors, both said the public relations program has come a long way. It got under way after a public opinion survey by a nationally known organization in 1945 revealed the industry's customers had many erroneous attitudes and beliefs regarding the industry.

The program went up several "blind alleys" in its early years, but has now arrived at a well-coordinated and well-directed program.

Brown stressed the necessity for still greater participation in public relations activities. He said more than 25,000 oil men worked on the assignments this year. This was a 40 per cent increase in the number of volunteers.

Most enthusiastic response to the program has come in the expanded school program which promises to become outstandingly successful as a long-range activity.

During the year representatives of the industry contacted 85 per cent of the daily newspapers, 79 per cent of the radio stations, 90 per cent of the TV stations and 38 per cent of the weekly newspapers to present material promoting better public relations.

The program is getting greater participation from dealers and jobbers and major emphasis on this part of the program will be given in 1955, Brown said.

National advertising, which accounts for about half the budget, is getting wider and more penetrating readership. This portion of the program has been subject to some criticism from within the industry because of differences in opinion over the effectiveness of the material used. National organizations say the advertising now has penetration as good as similar type presentations.

Program praised . . . Praise for the public relations program came from Dr. Claude Robinson, president of the Opinion Research Corp., a national authority on public attitudes toward business and industry.

"No one, to our knowledge, has worked more diligently or more intelligently than O.I.I.C.," Dr. Robinson said. "The committee has never been content to coast along but has constantly been reaching for new ideas. It is our profesisonal judgment that O.I.I.C. has written and is writing a significant chapter in the art of public persuasion."

More compliments . . . Governor Robert F. Kennon of Louisiana complimented the oil industry on its efforts to keep the public informed of its services and activities. He said this was the base on which the industry could prevent the spread of governmental controls such as the recent U. S. Supreme Court decision giving the Federal Power Commission control over the production of natural gas moving in interstate commerce.

"Since you have a good story to tell" Kennon said, "I am certain of the success of the oil industry's campaign to speak up and inform the public. A well-informed American public will always make the right decision."

Independent, major stage . . .

. . . Debate on Imports

CHICAGO.—The battle over imports was laid before the A.P.I. by a spokesman for independent producers and a representative of a big importing company.

Notice that producers will fight for a protective tariff on oil—and a plea for the rest of the industry to join the battle—was given by W. M. Vaughey, president of the Independent Petroleum Association of America.

But M. J. Rathbone, president of Standard Oil Co. (N. J.), reiterated the position of foreign operators that new restrictions are unwise and unneeded, that imports are not disastrous, and that the industry can handle the problem within itself.

Vaughey and Rathbone were the only speakers on the entire program to more than skirt this controversial subject. Both of them stated their positions plainly but dispassionately.

The independent . . . Said Vaughey:

"This problem (of imports), from our viewpoint, is far from solved. It is not my viewpoint that any one large importing company is going to try and deliberately eliminate us. But whether it is intentional or otherwise, if the end result is the same, the consequences are serious . . .

"The excessive importation of petroleum and its refined products is imprudent and also shortsighted . . . the change from a net exporter to a steadily increasing net importer has meant a loss of market for domestic production . . . the impact is crippling . . . we are now in the first stage of a creeping paralysis . . .

"The problem is not going to solve itself. In time, worldwide increased demand will bring some relief . . . but I do not believe we can afford to wait for that solution.

"Domestic producers, regardless of size, are in a precarious position. The fact that we have not yet been brought to our knees certainly does not prove the distress signals are meaningless . . .

"Legislative relief from congress . . . appears to be the only course left open . . . I am talking about a protective limitation tariff . . . we are prepared to pursue this course . . .

"It is wishful thinking to presume that there is any hope for the companies importing oil to voluntarily restrict their volume to the degree necessary to put our industry in balance . . . a legislative formula . . . might be a welcome relief to the management of the importing companies . . .

"In behalf of the domestic producers of oil and gas, I beseech you . . . to join us in making certain that a rightful place be preserved for us in this important petroleum industry."

The major . . . Rathbone was equally explicit.

"The question is simple; whether to use oil supplies from abroad when we have so much available at home right now," said the Jersey president. Then he went on:

"Involved in this question are the broadest kind of considerations—international relations, the free-world struggle against communism, national defense, the principles of proration, the conservation and most efficient use of American domestic resources, even the basic principles of the free-enterprise system.

"These factors are far too important to permit short-term or expedient answers to the basic question.

"Jersey Standard believes that this country should import oil to supplement our domestic supply, which, while surely very large, is much less in proportion to our consumption than that of the rest of the world.

"We believe we should import oil to foster and expand international trade which is so vital to our country and so important to our relationships with friendly foreign lands.

"We recognize fully that, particularly in periods of domestic oversupply, the question of imports is one of real concern to domestic producers . . . This fact should be given most careful consideration by the importing companies . . . The situation calls for the highest order of business judgment by all concerned.

"We believe the oil industry itself can find its way through this difficult problem, always keeping before it two cardinal principles—to maintain a vigorous and progressive domestic petroleum industry, and to meet the requirements of national security.

"We urge patience and restraint—and there is need for plenty of both on all sides.

"This is an industry problem. Only within the industry can the needed flexibility, knowledge, judgment, and ability be brought to bear on its proper solution.

"We do not believe in legislative distortion of economic law. Legislative restrictions and dictates are not the right way to solve this problem."

Gas Supplies Threatened

Kuykendall emphasizes FPC didn't want price-fixing job; producers' risks are recognized by the agency, he says

CHICAGO.—The prospect that federal control of natural-gas prices will reduce the supply of gas for consumers was unanimously recognized by half a dozen speakers at the A.P.I. meeting—including Chairman Jerome K. Kuykendall of the Federal Power Commission.

Even the fuel-oil dealers who have lost markets to gas in recent years joined the rest of the industry in advocating congressional legislation to provide a free market for gas producers. The fuel-oil dealers told themselves that more aggressive selling methods for oil and the freedom of gas to seek its competitive price level will help solve their problems *(see Marketing)*.

Kuykendall didn't specifically advocate legislation to cancel out the price-fixing authority recently thrust upon his agency by the Supreme Court decision in the Phillips case, but he left the strong inference that FPC would welcome being taken off the hook.

FPC didn't want the assignment, he stressed, but has to apply the law as directed. It realizes it is up against some very tough problems.

"FPC recognizes that the characteristics of the gas-producing industry are quite different from those of the gas transmission industry. . . . That the business of exploring for and developing natural-gas reserves entails many risks, and that the financial rewards must be commensurate with those risks if exploration, drilling, and production are to continue. We intend to recognize this indisputable fact in our rate making, no matter what methods may be

employed in testing the reasonableness of producers' rates. . . .

Help wanted . . . Kuykendall said the FPC will shortly request the industry to suggest to it methods and standards for regulating the price of natural gas sold by producers in interstate commerce for resale. He asked for the best thought on "the difficult problem."

The FPC chairman ended with a plea for better understanding of the FPC by the gas industry, better understanding of the industry by FPC. Also he termed it highly desirable that the public have a better understanding of the industry's problems and that the industry obtain a "fuller comprehension of the public's apprehensions and misapprehensions"—apparently an endorsement of the industry's current campaign to get public support for amending the Natural Gas Act.

"We want you to be economically healthy," he said, "healthy enough to continue to produce the oil and gas America needs.

"In other words, we do not want to socialize the natural-gas industry."

Top problem . . . Despite these reassuring words from the head of FPC, industry men listed federal regulation of gas production as their most pressing problem of the day. API president Frank Porter devoted half his annual report to it, saying gas simply cannot be made available in sufficient quantities if producers are subject to any sort of utility regulation.

"Please understand," Porter said, "that the inability of the operator to make his gas available for sale under utility controls is not a producers' strike. The simple proposition is that the search for and production of gas cannot survive under utility controls.

"Natural gas . . . has invaded and captured some of the market heretofore supplied by competing fuels. I do not believe, however, that other fuel industries favor the price-fixing of a competitive commodity while still in the hands of the producer or owner."

Shortage forecast . . . Indiana Standard's John Boatwright, too, listed FPC regulation as one of the prime hazards of the industry today. "This is an intolerable situation . . . I do not see how it can be cured other than by positive action through clarifying legislation. Rates payable for natural gas in the field must be those dictated by a competitive market if we are to meet the demands thrown upon the industry."

Unlike some observers, Boatwright saw little good in the suggestion that FPC adopt flat field prices instead of trying to fix the cost of gas from each well on a utility basis.

Such a course, he said opens some interesting—and frightening—possibilities:

. . . Artificially low rates for the consumer might stimulate demand for natural gas even more than direct state-commission regulation has stimulated it in the past. Such stimulation could lead to an even more thorough replacement of solid fuels than we know today.

. . . Little economic incentive to search for supplies of gas or even produce them when accidentally found. The artificially low rate could—in fact, almost certainly would—discourage the development of increased supplies of natural gas.

. . . A crippling fuel shortage fuel shortage in this nation could result from the combination of increased demand and decreased supply. We might have millions of homes and industries equipped for using gas—and inadequate gas with which to supply them.

Pipeliners help . . . Assurance that gas pipeline companies will assist the producers in seeking freedom from FPC regulation was given the institute by Gardiner Symonds, president of Tennessee Gas Transmission Co.

In fact, he was much more optimistic about the prospects for early congressional action than Porter, who had said, "corrective legislation will not be easy."

Calling for a "long look" toward the problem, Symonds said that if the public and Congress consider the issues on a long-range rather than a short-term basis the legislation has a real chance of being passed.

He based this on the assumption that the public can be convinced that a free market will produce adequate supplies at reasonable prices but low prices fixed by regulation will soon cut down supplies.

With more offshore drilling . . .

. . . Costs Should Drop

CHICAGO.—Economics is not the sole consideration in development of offshore reserves but the oil industry is doing a reasonably respectful job costwise.

These conclusions were reached by Dean A. McGee, president of Kerr-McGee Oil Industries, Inc., in discussing offshore economics before the A.P.I. production division.

Offshore operations are attractive at current costs and are comparable now with some of the areas of the United States where exploration and development are being aggressively pursued, McGee said. He predicts drilling and operating costs will be reduced materially as companies gain more experience.

Equipment costs . . . A reversal in equipment costs is due. Investments in

INDUSTRY-WIDE PROGRAMS sponsored by the A.P.I. emerge from small groups such as the Production Committee on Vocational Training. It is presided over by T. A. Atkinson, Douglas Oil Co. of California, Los Angeles.

offshore drilling equipment now range from $2,115,000 for a self-contained platform in 60 ft. of water, up to $4,115,000 for portable platforms or similar devices capable of drilling in 100 ft. of water.

While the industry has expected costs to taper off with improved methods, McGee said actual costs have been rising. New devices are costing more than those now in use. To some extent this is a reflection of the relatively low cost of much war surplus equipment, such as LST's which must now be replaced at much higher prices. Also, new outfits are being designed for operation in deeper water. Accomplishment of the objective of drilling in 100-ft. water is temporarily assuming more importance than its cost.

McGee noted that none of the devices now in use is completely competitive at all water depths. The submersible barge is definitely limited to 40 ft. with existing models. The large mobile devices being constructed for water up to 100 ft. will not be competitive at depths of less than 40 ft. because of high initial cost. The floating tender-small platform approaches being a method that is competitive at all water depths.

Operators were warned against building too much drilling equipment of the single purpose character now in use. There is a possibility or even a probability that this type of equipment will be obsolete in the near future. However, the steadily increasing requirements of developing tidelands leases call for building more drilling units. As of September 1, McGee said 39 units were available and 5 were under construction. Of the total available, 5 were mobile devices, 29 were drilling tenders and 5 were rigs on self-contained platforms.

Operating costs . . . "The cost of producing oil and gas may be an equally, or even more, significant factor in the over-all economics of the development of offshore oil and gas fields than the cost of exploratory and development drilling," said McGee. "Each producing operation has its own peculiar problems."

A fairly representative area making about 14 per cent of total production off the Louisiana Coast was selected for a study of producing costs. All methods were covered except the one using the pipeline for onshore movement of oil.

The costs of production of wells into moored barges or central storage batteries appear to be about 80 cents per barrel. These costs do not include 13 to 25 cents per barrel for moving production to land.

Distillates Slowing Up

Dyer says saturation point approaching for certain uses; natural gas pictured as competitor most likely to succeed

CHICAGO.—The time has arrived for the oil industry to be concerned about the future market for its distillate fuels.

After a postwar expansion in distillate demands which paced all other major products many of the demands are leveling off. This is due both to the competition of other fuels and the fact that the saturation point appears to be approaching in certain distillate uses.

This alarm was sounded for the first time on a national basis at a group session of the marketing division of the A.P.I. here.

"We now find ourselves at the point where the free ride has come almost to an end," J. E. Dyer, president of the Sinclair Refining Co., said.

Reviewing the growth of distillate fuels, Dyer pointed out that since 1939 the demand has increased from 370,000 bbl. daily to 1,351,000 bbl. daily last year, a gain of 265 per cent. For the same period, the gain in gasoline demand was 122 per cent. All segments of the industry have benefited from this record expansion in distillate demand.

Dyer said that heating oil sales went up 57 per cent the first 4 postwar years, continued to rise 41 per cent the next 4 years but with only a 2 per cent increase in 1953 over 1952.

Dyer blames the competition of natural gas for the situation that has developed in heating oil sales.

"In the years before World War II, oil heating was outselling gas heating 3 to 1," he said. "Since the war, the ratio has been about equal. While oil heating nationally is still strong, a lot of individual large markets have been hurt badly. In some places gas is outselling oil 3 to 1."

Diesels slowing, too . . . Dyer said that the growth rate in demand for diesel fuels by the railroads and other users will also be slowing down. Last year this demand accounted for 15 per cent of the total distillate demand. The increase from 1939 through 1953 represented the steepest single increase of any of the distillate uses. The slowing rate of increase for diesel fuel is based on the fact that 80 per cent of locomotives now burn diesel and gains of the past cannot be duplicated in the future.

There have been decreases or a leveling off in demand for the remaining 30 per cent uses of distillate fuels, according to Dyer.

In addition to that from natural gas, Dyer predicted competition for distillate fuels will come from other sources. He mentioned heat pumps which are coming within the price range of the average homeowner.

CHALLENGE OF COMPETITION threatening the oil industry is being met by the Marketing Personnel Training Committee, headed by E. J. McClanahan, Standard Oil Co. of California, San Francisco.

Salesmanship . . . Dyer's solution for conditions is more and better selling.

"Parenthetically, I would like to point out that many of the sales points used by the gas people to gain ground in the heating market are the same ones that this industry used 20 years ago to first sell automatic heat," he said. "We have assumed that people know our story and have let our sales weapons fall into disuse. These weapons are now being turned against us and will hurt us unless we regain the initiative."

Multigrade Oils Praised

Sovac executive says they improve performance of engine and reduce octane-number requirement

CHICAGO.—Multigrade motor oils, because of their contributions to improved engine performance, apparently are here to stay.

Development of such oils is just one phase of the current revolution in the quality of lubricants serving all types of markets in the industrial and motor-vehicle field. Manufacturers of lubricants will continue to face a major task in perfecting their products to meet new applications.

These are among the trends noted by P. V. Keyser, Jr., domestic marketing manager of Socony-Vacuum Oil Co., Inc., in an address at the lubrication session of the annual A.P.I. meeting.

Never before in history of the industry have there been so many technical developments by equipment manufacturers and oil companies affecting lubrication, Keyser said.

New oils . . . The multigrade oils have in effect reduced octane requirements of motor fuels, he explained.

"Any reduction in octane-number requirement achieved through the lubricating oil is equivalent to a corresponding reduction in fuel octane numbers," Keyser said. "To the engine builder this means higher compression ratio for a given fuel octane number, and to the refiner it means reduced capital investment for facilities at the ultimate level of fuel quality."

One result of this development, according to Keyser, will be reduced demand for bright stocks. This means refiners will have to find other uses for these products.

Transmission fluids . . . Another important trend affecting the lubricating-oil industry is the growth of transmission-fluid consumption. Since the introduction of the first automatic transmission in 1937, it has become so popular that more than half of the new cars have such equipment.

The growing business in transmission fluid has come at the expense of gear lubricants, which are expected to give way almost entirely to the new products in the not-too-distant future.

Complex nature of automatic transmissions places an obligation on the oil manufacturer to provide a fluid which will permit them to operate reliably and smoothly even during unduly long change periods, Keyser warned.

Other developments . . . Hydraulic fluids for loading and transmission devices in industrial machines are finding wider and wider use. Superior products are necessary to safeguard these high-cost pieces of equipment, and the lubricant cost is a minor item.

In some industrial and military applications, a further requirement is that the fluid be fire-resistant. Synthetic, non-petroleum fluids, despite their higher cost, are finding acceptance in this service.

Petroleum lubricants also are losing the aircraft gas-turbine oil market to synthetics which, though much higher in cost, do a satisfactory job in meeting the severe requirements.

In each of these fields, Keyser stressed, there is a firm demand for higher-quality products with no buyer resistance to higher prices.

The future . . . Reductions in crankcase capacity of automobiles and the trend toward less-frequent oil changes contribute to the fact that the consumption of motor oils is not keeping pace with the increase in the number of registered motor vehicles, Keyser explained.

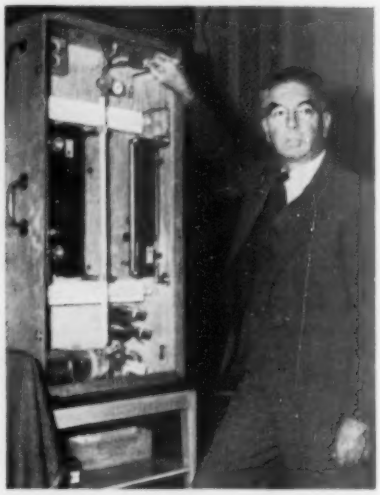
He pointed out that the average crankcase capacity of passenger-car engines 20 years ago was seven quarts compared to five at present. He urged the industry to promote frequency of change of motor oils by car owners.

"Our success as individual companies depends on our ability to give customers ever-better values," Keyser concluded.

"This we shall have as long as we continue to have strong and healthy competition, and this depends largely on progressive research and product development which are inspired by the incentives provided by the opportunity for profits. True value cannot be measured in terms of cents per gallon. It can be measured only in terms of what the product and service together do for the equipment."

DRAMA surrounding the A.P.I.'s continuous research into the mysteries of petroleum sometimes match those of a Little Theater production. Caught in a dramatic pose as he puts over a point at a committee meeting is Dr. Alfred Chatenuer (left), University of Oklahoma. Looking on are (left to right) Dr. E. R. Brownescombe, Atlantic Refining Co., Dallas, advisory committee chairman; Dr. Gerhard Herzog, The Texas Co., Bellaire, Tex.; Dr. Peter Debye, Cornell University; and R. F. Faulle, California Research Corp., La Habra, Calif.

GRAPHIC DEMONSTRATIONS such as this enlivened reports on fundamental research on composition and properties of petroleum. Wheeler Lovell (left), of Ethyl Corp., Detroit, explains the setup used by Project 45 to fellow project chairmen G. R. Lake, Union Oil Co., Los Angeles; Arthur L. Lyman, California Research Corp., San Francisco; H. W. Field, Atlantic Refining Co., Philadelphia; W. D. Seyfried, Humble Oil & Refining Co., Baytown, Tex.; Sherman S. Shaffer, Humble; and H. Sutherland, Shell Development Co., New York. Engine at left demonstrated marked difference in octane rating occasioned by shifting the double bond in the seven-carbon olefin shown on table.



ONE TECHNIQUE used in separation and purification of hydrocarbon components of petroleum was shown in this demonstration. Sherman S. Shaffer, Humble, separates a mixture of an olefin and an aromatic by selective adsorption on silica gel. This mixture was desorbed or "chased" with ethyl alcohol, proving scientists are different.

Research in mysteries of oil holds . . .

. . . Keys to Industry's Growth

CHICAGO.—The reservoir of technical knowledge which will help mold the future of the petroleum industry is being continually repressured.

Last week's report on fundamental research sponsored by the American Petroleum Institute indicated tomorrow's technology will have a vast supply of basic data pertaining to the occurrence, recovery, composition, and properties of petroleum. Research papers presented at the annual A.P.I. meeting stressed, in particular, the progress made in studies of oil's composition and properties.

The oil business is supporting the largest and most productive of any industry-wide research project in existence, said Howard G. Vesper, vice president of Standard Oil Co. of California. Vesper is retiring chairman of the A.P.I.'s advisory committee on Fundamental Research on Composition and Properties of Petroleum.

The industry is providing a growing pool of information which no individual company can afford to obtain singly. This information serves all industry members in their applied research directed toward improving yield and quality of refined products.

The present advisory committee chairman, Hugh W. Field, vice president of Atlantic Refining Co., introduced the respective chairmen of seven current "C. & P." projects.

Separation techniques . . . Clues to future means for separating petroleum components are disclosed in reports from the Project 6 team on analysis, purification and properties of petroleum hydrocarbons.

This team has pioneered in precise separation by numerous techniques: distillation, extraction, adsorption, crystallization, and formation of molecular or clathrate compounds. Basic refining procedures employ most of these tools, and further light on improved techniques is being shed by this 28-year old project.

Principal targets of Project 6 remain the fractionation of hydrocarbons from petroleum and the purification of such hydrocarbons for availability as A.P.I. standard and research compounds. As of last June, 141 hydrocarbons had been isolated from the project's representative petroleum, and 228 A.P.I. research hydrocarbons had been purified.

This pool of hydrocarbons is available to qualified research groups for further investigations pointing to higher-quality products in the future.

Synthesis work . . . An important contributor to the pool of A.P.I. standard hydrocarbons is Project 45 dealing with synthesis, purification, and properties of hydrocarbons boiling mainly in the gasoline range. Some 300 of these have been made and passed on to the standards pool.

These hydrocarbons also go to research laboratories of General Motors Corp., and Ethyl Corp. where their patterns of behavior are determined under varying conditions in knock-testing engines.

Out of this work, for example, has come a clearer conception of the influence of double bonds on octane ratings and lead susceptibility of these pure hydrocarbons.

Such evaluation work is only beginning. The blending characteristics of these pure hydrocarbons also vary, and they will be covered by future studies. This project is leading the way to possible formulation of higher-octane

fuels through research by individual companies.

Sulfur studies . . . Sulfur compounds in petroleum are a growing headache to all divisions of the indutsry. Project 48, dealing in synthesis, properties and identification of sulfur compounds in petroleum, is trying to ease the headache.

Vital importance of basic data on this class of compounds is indicated by the millions of dollars now being spent in hydrodesulfurization and similar processes in domestic refineries.

To date the project has identified 43 pure compounds mostly in the gasoline range, including 14 straight chain sulfides, 6 cyclic sulfides and 23 mercaptans. This research is limited for all practical purposes, to the low-molecular-weight compounds because of the extreme complexity of heavier sulfur compounds.

However, data on the lighter components can serve as clues to the analysis and characteristics of the higher-boiling constituents which appear to consist mostly of condensed ring systems containing sulfur.

A thorough study of sour Wasson crude shows the presence of thiophenes or ring compounds containing sulfur, in the heavy fraction of gasoline. It appears that the middle distillate and residual fractions of the crude comprise primarily, one, two and three-ring sulfur compounds with small percentages of straightchain compounds in middle distillate fractions. Data on all sulfur compounds and samples of the compounds themselves will prove highly useful in determining catalytic and other techniques for their removal in commercial manufacturing operations.

Nitrogen project . . . The baby of the seven composition and properties studies is No. 52, dealing with nitrogen constituents. Nitrogen compounds vary greatly among various crudes, but their presence even in minor concentrations is beginning to be felt in current processing.

Nitrogen is looming as a serious problem in reducing the activity of catalysts employed in reforming, polymerization, and isomerization. Nitrogen compounds contribute to formation of insoluble gums in diesel fuels and lacquer in engines, and they cause color deterioration in heavy fractions, such as lube oils.

Information on the quantity, structure, and characteristics of nitrogen compounds occurring in crude oil will be most welcome in the field of applied research where means of their removal by hydrotreating and other techniques are now under intensive development.

Other projects . . . The comprehensive research program sponsored by the A.P.I. also includes a variety of other studies, all aimed at more complete and efficient utilization of petroleum resources.

Other studies covered in reports at the annual meeting included Project 42 dealing with synthesis and properties of high-molecular-weight hydrocarbons, Project 44 covering data on hydrocarbons and related hydrocarbon compounds, and Project 50 on thermodynamic properties of hydrocarbons and related compounds.

Each of these research teams is searching for the right keys to open doors blocking future development of the industry.

A.P.I.——TRANSPORTATION

Pipeline Growth Forecast

Trend toward integration is described as major factor in cutting cost of transporting crude oil and products

CHICAGO.—Anticipated increase in demand for petroleum by 1975 will require pipeline facilities to move an additional 5,000,000 bbl. per day.

For efficient, economical handling of this volume, the pipeline industry will turn to more automatic controls, less interim tankage, and more extensive metering, J. H. McClintock, Esso Standard Oil Co., New York, told an A.P.I. symposium here.

In fact, McClintock said, there is no apparent reason why all measurement operations in both crude oil and refined products cannot be made fully automatic, including determination of quantities, calculation of losses, computation of royalties, and other end uses of the actual measurement.

Integration reduces costs . . . The tendency toward integration, with its opportunities for cost reduction, has been most pronounced in the petroleum industry in its utilization of crude oil and products pipelines, John G. McLean, professor of business administration, Harvard University, said. Integrated companies are more important in the petroleum industry than in almost any other U. S. industry.

The transportation function has been most significant in the growth of integration in the oil industry.

A company's refining expenses might run in the neighborhood of 50 to 60 cents per barrel. Management has little opportunity to reduce those costs by more than 5 to 10 cents per barrel,

TOP BRASS at the A.P.I. meeting included this casual-looking group caught between transportation sessions. Shown (left to right) are George H. Hill, Jr., Cities Service Oil Co., New York; Frank M. Porter, Fain-Porter Drilling Co., Oklahoma City, A.P.I. president; P. C. Spencer, Sinclair Oil Corp., New York, A.P.I. board chairman; B. Brewster Jennings, Socony-Vacuum Oil Co., A.P.I. treasurer; and Charles E. Spahr, Standard Oil Co. (Ohio), Cleveland.

JOHN G. McLEAN

Pipelines . . . easiest place to cut costs

no matter how much attention it devotes to the problem. Similarly, the company's marketing expenses might average somewhere between 60 to 90 cents per barrel, and the most stringent economies would be unlikely to produce savings much greater than 10 to 20 cents per barrel.

In recent years the substitution of pipeline for rail transportation has often provided savings of 50 cents or more per barrel, depending on the length of haul. Integration into pipeline transportation activities has constituted the single most important area in which a refining - marketing company could make gains vis-a-vis its competitors and improve its service to the public.

The opportunities for cost reduction have by no means been limited to transportation savings alone. In addition, the building of products pipelines has often enabled individual refineries to enlarge the geographic areas which they could serve on a competitive basis. As a result, the industry as a whole has been able to reduce the number and increase the average size of its plants.

Public relations . . . "In the field of pipeline operations the value of good will has long been recognized," Harry G. Schad, Atlantic Refining Co., Philadelphia, said. "We must equitably purchase our right-of-way, thus making every effort to avoid condemnation suits, and make equitable settlement for the damages which result from the construction—all to the goal that the landowner feels he has acquired a good neighbor rather than an unwelcome trespasser."

Fair treatment in daily business activities, Schad said, results in the greatest degree of cooperation and the creation of genuine good will.

Fewer bends, better lines . . . More emphasis should be given to perliminary processes of choosing the best possible right-of-way and to planning ditching at various depths, according to J. C. Stirling, Service Pipe Line Co., Tulsa.

Most companies can eliminate all vertical bends by grading the ditch properly and allowing the pipe to conform by virtue of its inherent elasticity. Contractors can eliminate unnecessary bending by operating the ditching machine at various depths. Fitting the pipe to ordinary ground contour can be accomplished by grading, widening, and curving the ditch. Avoiding abrupt changes in alignment or grade reduces bends to a minimum.

Ordinarily the contractor does not charge for bends, but he does for digging extra-deep ditches. Very few contracts call for extra payment for extra-deep ditches at crossings. Most companies are usually willing to trade a little deeper ditch for an extra bend. Right-of-way problems in developed areas often cause the making of horizontal bends; when this is the case, the companies set up specifications that will give free passage to scrapers, or go-devils.

Weld inspection . . . X-ray is indicated as the choice of radiographic source, according to Harold Hovland, Industrial X-ray Engineers, Seattle, Wash. Standardized qualification tests should be instituted for radiographers.

In addition to testing weld quality, radiographic inspection detects any trend of the welder to drift away from correct procedure.

Pipeline construction is loaded with the human element. Human beings change psychologically and physically. It is as important to have a constant and continuing check on a welder's production from day to day as it is to qualify him originally.

Procedural errors caused by improper spacing, improper lineup, movement

Your A.P.I. Coverage

The comprehensive coverage given this year's A.P.I. meeting by The Oil and Gas Journal was provided by six Journal staffers who attended the session. Representing the Journal were K. B. Barnes, C. O. Willson, Henry D. Ralph, George Weber, Paul Swain, and Paul Reed. The Journal's Latin American affiliate, Petroleo Interamericano, was represented by Oscar B. Irizarry, publisher and editor.

HARRY G. SCHAD

Success . . . revolves around good will

of the pipe, out-of-round pipe, variations in inside diameter, temperature changes, and changes in the chemical content of the steel are matters which the welder cannot always control. With adequate radiographic inspection, defects caused by these procedural errors will be identified and corrected.

Better filtering . . . Looking to the future, it will pay each operator to consider methods for improvement both in design of equipment and disposing of dirt remover by filters, according to W. G. Horstman and Ivy M. Parker, Plantation Pipe Line Co., Atlanta.

They believe that the jet - cleaning strainer with 400-mesh screen does a better filtering job and requires less time for maintenance and cleaning than any other means.

Research is being carried out on the use of diatomaceous - earth - coated screens. This material will collect rouge from a stream which appears clean to the eye. A procedure may be developed to coagulate the fine rouge and emulsion into large particles which will be easier to filter out and to remove from the system.

Lower coating costs . . . Where corrosive environments may vary, study is being given to determine the possible advantages of using coatings of different specifications, according to S. G. Kershner, Texas Pipe Line Co., Houston.

The economy of using the same coating specifications for any cross-country pipeline, regardless of its location or the corrosive nature of the soils along the route, is subject to question. A more economic coating may possibly be used in areas where the soil conditions

are more arid or the year-to-year climatic conditions are relatively colder.

The cost of pipeline coatings now represents some 6 to 7 per cent of the total cost of laying a line. For an 8-in. pipe the coating would cost about $1,500 per mile, and for 24-in. pipe about $4,000 per mile. Cathodic protection, when applied, will add some 5 to 6 per cent to these coating cost figures; and the resulting power costs for operation will average, over-all, approximately $3.50 per mile per year, depending on the length of the line and, to some extent, the diameter, as well as the coating condition.

Automation Gaining

A.P.I. symposium told there's no reason why measurement operation in crude, products can't be wholly automatic

CHICAGO.—A revolution in techniques for measuring, sampling, and testing oil and gas fractions promises to yield substantial returns in added profits and improved process control.

The potential gains in this field were recognized in a special symposium at the thirty-fourth annual A.P.I. meeting here last week.

Management is taking an active interest in this subject recognizing that present progress, however good, is not good enough. Automation has become a necessity in handling a growing volume of higher-valued product streams.

There is no apparent reason why the entire measurement operation in both crude oil and refined products cannot be made wholly automatic. This would include determination of net quantities, calculation of loss data, computation of crude-oil and gas royalties, recording of inventory-control statistics, and compilation of yield information.

Many types of measurements are now being made by electronic equipment. Various automatic or ground-level gages which can be equipped for remote reading are receiving wide acceptance and soon may find general use for custody transfer. Equally promising are other improvements now in development stages.

Practical applications have been made of large-size positive-displacement meters. Their obvious advantages when employed with automatic temperature compensation may in time eliminate the need for thermal correction of volumes. Printed-ticket methods are now in use with meters and could be applied to gaging techniques. Remote gaging and temperature measurement can now be adapted to record inventory data on a printed or punched card which would serve as an order card, as automatic loading or delivery card, and an accounting card.

Errors in temperature measurements and volume conversions may in time be bypassed by measurement equipment using the inherent accuracy of the beam balance counting equal increments of weight. Such equipment is now under development.

Quality measurements . . . Improved quality measurement is possible through automatic sampling for gravity or sediment and water testing. Sampling methods are under study and better samplers are coming. More representative samples are resulting from improved location and design of draw-off tubes, closer integration of sample volume and stream rate and better handling, testing and storing methods.

Much promise is attached to new developments in continuous quality evaluation without sampling. Several instruments in this field are now available or under development. Density measurements of fluids in transit can now be made by a number of methods. More difficult, but on the way is the determination of water and sediment content based on measurement of dielectric constant.

Dramatic progress is reported in development of spectrometric and other analytical instruments which will provide complete qualitative analyses of hydrocarbon streams. The next step is adaptation of such analytical devices to automatic control, as soon as reliable instruments are available. This application is now under development for automatic control of crude oil flow from lease-tank batteries.

Engineers visualize the eventual development of integrated systems using electronic calculators for direct measurement to hydrocarbons streams on a net-quantity or temperature-corrected basis. These would permit the condensation of separate operations for determining liquid level, temperature, viscosity, gravity, water and sediment to a push-button type of control, employing automatic pumps and valves. Plant inventories could then be reduced to a one-man, one-day job.

Benefits from wider application of automatic measurement and testing devices include a higher level of safety, more efficient employment of manpower, improved accuracy and a cleaner plant. These, plus the basic returns will justify the cost of such new devices and the operator training required.

Management viewpoints . . . Management visualizes further returns from automatic measuring and testing facilities. Emphasis is placed on the need for organizing and presenting day-to-day statistics for important decision-making. Timeliness is a prime consideration, not only in this respect, but in noting and correcting shortages in handling crude and products. Loss-control has become an important part of efficient plant operation and prompt and accurate measurements can contribute greatly to economy.

ANNUAL DINNER of the Pipe Liners Club attracted many industry leaders including (left to right) O. F. Moore, Ohio Oil Co., Findlay, Ohio; J. H. Wood, Jr., Atlantic Pipe Line Co., Dallas; Loren F. Kahle, Standard Oil Co. (N. J.), new club president; J. L. Latimer, Magnolia Petroleum Co., Dallas; and J. L. Burke, Service Pipe Line Co., Tulsa.

Division of Transportation:

JAMES E. DYER
Sinclair Refining Co.

ARTHUR M. GEE
Retired

A. B. GORMAN
Esso Standard Oil Co.

F. B. HUFNAGEL, JR.
Sun Oil Co.

Financial and Accounting:

J. R. MULVEY
Humble Oil & Refining Co.

Division of Marketing:

R. M. BARTLETT
Gulf Oil Corp.

JAMES E. DYER
Sinclair Refining Co.

Petroleum Industry Awards

CERTIFICATES of appreciation from the American Petroleum Institute were presented last week to the 29 men pictured on these pages.

The special awards are in recognition of outstanding service to the petroleum industry in varied fields of activity. The awards were made at group sessions on transportation, production, marketing, technical services, and public information.

Division of Production:

D. V. CARTER
Magnolia Petroleum Co.

J. C. JOHNSTON
Continental Oil Co.

C. V. MILLIKAN
Amerada Petroleum Corp.

P. A. MILLS
Moody Engineering Co.

C. E. REISTLE, JR.
Humble Oil & Refining Co.

W. F. JONES
Gulf Oil Corp.

C. B. LESTER
Mid-Valley Pipeline Co.

H. L. McREYNOLDS
Retired

A. O. PEGG
Deceased

S. S. SMITH
Retired

B. I. GRAVES
Retired

A. L. NICKERSON
Socony-Vacuum Oil Co.

ADRIAN M. OGLE
Petroleum Retailers Congress

HENRY L. SCHWARTZ
Paragon Oil Co.

RUSSEL S. WILLIAMS
Gasteria, Inc.

30 Appreciation Certificates

Technical Services:

LESLIE C. BEARD, JR.
Socony-Vacuum Oil Co.

BERT MARTIN
Retired

T. V. MOORE
Standard Oil Development

WILLIAM E. SODEN
Retired

Oil Industry Information Committee:

A. D. EUBANK
Quaker State Oil Refining

DONALD R. FERRIS
Gulf Oil Corp.

C. D. HILL
Carter Oil Co.

E. A. WILLIFORD
Continental Oil Co.

Some surprises unwrapped as...

...Texas Shelf Tracts Are Leased

WASHINGTON. — Further evidence that many oil men consider the Continental Shelf the No. 1 domestic oil frontier was presented last week when bids were opened for federal leases off Texas.

Many observers expected little action from the Bureau of Land Management's sale of the 38 tracts off Texas. The scramble for some of the tracts proved them wrong.

Total bonuses paid by the companies—$23,157,027—was not too impressive. The Government received $129 million October 13 for tracts off the coast of Louisiana. *(The Oil and Gas Journal, October 18, page 70).* But, on close examination, some of the bids are impressive.

One tract comprising 1,440 acres brought a bid of $3,180,960—or $2,209 an acre. This is almost double the top acreage bid of $1,220 paid at the Louisiana leasing. Magnolia Petroleum Co. paid the $2,209-an-acre price for the southwest quarter of Block 52 in the High Island area.

Magnolia's bid becomes even more impressive when you consider that less is generally known about the Texas tracts in comparison to the Louisiana areas, and operating conditions off Texas are less desirable.

Two other per-acre bids topped the $1,220 figure received in the Louisiana bidding. Standard Oil Co. of Texas paid $1,347 an acre for the 1,440 acres comprising the southeast quarter of Block 52 off High Island and $1,236 an acre for the 1,440 acres making up the northeast quarter of Block 68.

The highest total bid submitted at the November 9 sale was $4,565,251 paid by Standard of Texas for a 5,760-acre tract in Block 140 off High Island.

Only 19 of the 38 tracts offered drew bids. Those bringing bids totaled approximately 44,147 acres. Total acreage offered was 111,789 acres. The 38 tracts offered total about 5 per cent of the leasable off the outer Continental Shelf of Texas. *(For map of tracts see The Oil and Gas Journal, November 1, page 66).*

Because most of the tracts offered were smaller than those sold off Louisiana, the bonus totals offered ran correspondingly lower. But seven of the 19 tracts brought in excess of $1,000,000 each and four brought in more than $2,000,000.

The Interior Department reported 90 proposals were received for the 19 tracts. Competition for many was keen, with one bringing 10 offers.

Unlike the Louisiana sale, there were no tying bids, but Standard of Texas safeguarded itself by tacking 99 cents on to each bonus offered.

The tract Magnolia got for $2,209 an acre was sought by nine other companies, two of whom offered more than $1,000 an acre. The second highest bid was $1,236.11 an acre from Standard of Texas and the third highest $1,042.37 an acre from a combination of Pure Oil Co., Ohio Oil Co., Sun Oil Co., and Seaboard Oil Co.

The lowest bid made was $16.30 an acre from Gulf Oil Corp. for a 1,760-acre tract in Block 742 off Mustang Island. Four other tracts brought less than $20 an acre.

Stanotex . . . Standard of Texas, owner of the first and only commercial oil production off Texas, also topped all other companies in the total amount spent in the Texas bidding. The company acquired six tracts with bids totaling approximately $10,165,200.

The six tracts are in the High Island area about 18 miles from the shore of

May Win Reprieve

WASHINGTON.—The Government apparently will cancel $15 million in mistaken bids made by Kerr-McGee Oil Industries, Inc., in the federal leasing of Louisiana offshore tracts last month.

Frank H. Weitzel, acting comptroller general, has recommended that the Interior Department kill the company's bids and return $2,932,800 "earnest money." He made his recommendation to Interior Undersecretary Clarence A. Davies.

The Kermac error resulted from the company getting the block and tract numbers mixed up. In the scramble, the company was successful bidder on nine tracts, but quickly requested the bids be withdrawn once the mistake was discovered.

In referring the matter to Weitzel, Davis said Kermac's bids were "perfect" and that any mistake made was "the result of gross and unilateral negligence." But Davis also said Interior would comply with any recommendation made by Weitzel.

What it cost the winners...

Company—	Block No.	Acreage	Bid	Price per acre
MUSTANG ISLAND				
Atlantic Refining Co. and Tide Water Associated Oil Co.	725	5,613.73	$2,250,017	$400.81
Tide Water Associated Oil Co.	726	5,582.96	3,650,017	653.78
Tide Water Associated Oil Co.	727	5,552.01	106,000	19.09
Gulf Oil Corp.	742	5,760	93,888	16.30
MATAGORDA ISLAND				
Atlantic Refining Co. and Tide Water Associated Oil Co.	716	5,760	106,000	18.40
Gulf Oil Corp.	717	5,760	152,720	26.51
Atlantic Refining Co. and Tide Water Associated Oil Co.	718 (E½)	2,880	76,000	26.39
HIGH ISLAND				
Continental Oil Co., Atlantic Refining Co., and Tide Water Associated Oil Co.	51 (SE¼)	1,440	25,250	17.53
Phillips Petroleum Co.	52 (NE¼)	1,440	250,666	174.07
Magnolia Petroleum Co.	52 (NW¼)	1,440	1,694,880	1,177.00
Magnolia Petroleum Co.	52 (SW¼)	1,440	3,180,960	2,209.00
Standard Oil Co. (Texas)	52 (SE¼)	1,440	1,940,000	1,347.22
Continental Oil Co.	53 (SE¼)	1,440	777,007	539.59
Standard Oil Co. (Texas)	68 (NE¼)	1,440	1,780,000	1,236.11
Standard Oil Co. (Texas)	68 (NW¼)	1,440	251,000	174.30
Standard Oil Co. (Texas)	69 (NW¼)	1,440	802,200	557.08
Standard Oil Co. (Texas)	108	5,760	826,749	143.53
Continental Oil Co., Atlantic Refining Co., and Tide Water Associated Oil Co.	139	5,760	103,000	17.88
Standard Oil Co. (Texas)	140	5,760	4,565,251	792.57

Jefferson County in water from 40 to 50 ft. deep. Stanotex's current offshore production off Padre Island is in about 40 ft. of water.

In addition to the discovery well, Stanotex has drilled two directional wells and laid a pipeline from the shore of Kelberg County, moving the oil from the platform to the Corpus Christi refining area.

Offshore forecast . . . While the companies were preparing their bids for the Texas leasing, two Humble Oil & Refining Co. geologists, O. W. Noland, New Orleans, and Roy M. Huffington, Houston, were making the latest forecast of offshore production.

The pair predicted the fields off Texas and Louisiana eventually will produce 10 billion barrels of oil.

Noland and Huffington were addressing the fourth annual meeting of the Gulf Coast Association of Geological Societies.

Gulf Coast Strike Made

ORANGE, Tex.—J. C. Means, Jr., and William Seale, independent operators, have a new Gulf Coast oil-field discovery 7½ miles northwest of here in northeastern Orange County.

Their 1-A Powell testing a casing-perforated interval at 8,234-36 ft. in Hackberry sand, flowed at the rate of 315 bbl. of 37°-gravity oil per day through 10/64-in. choke under pressure of 3,400 psi. Flow was with gas-oil ratio of 1,975 cu. ft. per barrel.

Location is 3½ miles from neatest production, located in Hartburg field, in southern Newton County.

Indications of the discovery were given in a previous well, located 660 ft. to the east, which was junked and abandoned with stuck drill-pipe after encountering strong gas pressures while drilling at 8,530 ft.

Steel Price Rates Revised

TULSA.—Jones & Laughlin Steel Corp., Supply Division, will carry oil-country tubular goods "in transit" storage at Houston and at certain other barge terminals.

For pipe in carload lots moving through these terminal points, net prices F.O.B. cars or truck will be applicable. These net prices will be computed at carload mill base plus 4 per cent published barge rate (500-ton minimum) with surcharge, tax, and insurance from Aliquippa, Pa. The total delivered price will be figured by adding to the above mentioned net prices the published rail or truck rate from barge terminal point to destination.

Engine Deposits Studied

Research engineers concentrate on carburetor gumming associated with late-model cars, stop-and-go driving

John C. Reidel

TULSA. — What causes carburetor gumming and how can it be prevented? How can a fast laboratory test be developed to predict gum deposits in engines?

These questions occupied the attention of the Society of Automotive Engineers at its annual fuels and lubricants meeting here last week. Standard Oil Co. of California reported use of a detergent gasoline which apparently solves the problem. The use of the single-cylinder Lauson test engine and development of a bench-scale test procedure for engine deposits was reported by the Union Oil Co.

Cause . . . The carburetor-gumming problem has received more attention recently with the advent of two-throat and four-throat carburetors in late-model cars. Carburetor cleanup is required more frequently and this service is more expensive. Gum deposits result in rough, rich idling, loss of idle adjustment, and perhaps even in inlet-valve sticking and engine stalling.

Gumming is visualized as taking place, due to contaminants in the inlet air, while the engine is idling. Thus it is associated with stop-and-go city driving. One cause could be blow-by from the engine crankcase vent to the intake air cleaner while the engine is idling in a long traffic line. A smoggy city atmosphere, such as that in Los Angeles, with relatively high content of smoke, dust, ozone, and nitric acid, is also thought to be a contributing factor.

And solution . . . Investigation begun by California Research Corp. several years ago resulted in production of a "detergent-action" gasoline. In normal operation, that is at speeds above idling, this detergent gasoline removes deposits from the throttle body and other parts of the carburetor. Tests also showed that improved gasoline mileage is obtained.

An accepted standard for gasoline quality with respect to induction-system cleanliness is the A.S.T.M. existent-gum test. This, however, often loses its meaning inasmuch as a fuel may show low A.S.T.M. gum while high engine deposits may occur in service.

Lauson engine . . . The Union Oil Co. research men attacked the problem in a different manner. Gums taken from carburetors in service were divided into naphtha-soluble and acetone-soluble gums, and work was done to correlate the acetone-soluble gums from the Lauson test engine with field service results. An induction-system deposit (I.S.D.) bench-scale procedure was developed which gives results showing good correlation with service-engine deposits.

The gasoline sample is evaporated during exactly 2 hours. The gasoline goes through a flow meter and regulating stopcock to the fuel-inlet nozzle and flash evaporates in the ascending stream of warm air. Following evaporation, the gums are leached with hexane-heptane solvent, then dissolved in acetone.

Acetone-soluble gums were used because they gave more constant results. The Lauson engine test is of limited usefulness since it requires a test sample of 3 to 4 gallons and the test requires too much time. Even more important, reproducibility of results is not entirely satisfactory.

The simplified test, such as the Union I.S.D. procedure and that of other companies, provides for flash evaporation which more nearly simulates carburetion in the automobile induction system than does the A.S.T.M. test. Some 100 determinations made on 39 gasoline samples by the I.S.D. indicated that the standard deviation of individual determinations from the mean was plus or minus 7.4 per cent.

The I.S.D. test is also set up for nearly complete collection of the gum from normal fuels. It therefore does not show the effect of detergents. A need remains, therefore, for development of another laboratory test that will evaluate the action of fuel additives.

Sherry Sells 201 Wells

EL DORADO, Ark.—Murphy Corp. of El Dorado has paid William J. Sherry of Tulsa $6,000,000 for all of the producing oil and gas leases that Sherry received in exchange for his 62 per cent of the capital stock in Marine Oil Co., also of El Dorado, in a recent partial liquidation.

The deal, effective November 1, involved 201 wells located in East Poplar field of Roosevelt County, Montana, in the East Texas field, and in Smackover, Urbana, New London, North New London, and Shuler fields of Arkansas.

Murphy Corp., which owned 20 per cent of Marine's capital stock before

the partial liquidation, now has 98 per cent of the outstanding stock. Marine Oil will continue to operate as a subsidiary of Murphy Corp.

Union Sets Meeting

O.W.I.U. merger expected at convention in February

DENVER.—The Oil Workers International Union will hold its regular convention February 25, 1955, in Cleveland to vote on proposed merger with the United Gas, Coke and Chemical Workers.

Quick approval of the merger plan involving the two C.I.O. groups is expected. O. A. Knight, O.W.I.U. president, was so confident of the outcome that he announced a merger convention will open February 28, also in Cleveland.

The chemical workers approved the merger at their recent convention in St. Louis.

The oil workers' international meeting was originally slated for November 15 in Cleveland, but was postponed after the chemical workers decided against an immediate meeting with the O.W.I.U. to complete the merger.

Chemical workers' officials announced then that the group lacked sufficient funds to put on the meeting and needed more time to brief locals on the merger.

Knight said the O.W.I.U. executive committee set the new convention dates after being advised the chemical workers had agreed to a joint merger meeting "in March or an adjacent month."

The O.W.I.U. represents approximately 125,000 workers. The chemical workers' union represents about 100,000.

The three-day executive committee meeting which opened last week preceded a session of the O.W.I.U. policy committee at which union leaders were expected to draft new campaign strategy for wage boosts.

Little Inch Hearing Set

WASHINGTON.—The Little Inch pipeline, which has gone from products to gas, will find out whether it will return to products service when Federal Power Commission begins hearings on Texas Eastern Transmission Corp.'s application here December 6.

Texas Eastern, which bought the line from the Government after the war, and converted it to gas, plans to use the line for products again. However, it is being contested in its plans by American Pipe Line Co., and a group of Mississippi barge operators *(The Oil and Gas Journal, September 6, page 63)*.

American, which has proposed to build a 1,445-mile products carrier from Beaumont to Newark, opposes the conversion as being inadequate.

FPC Faces Court Test

Gas producers take legal action to prevent enforcement of controversial order controlling sales to pipelines

TULSA.—The Federal Power Commission was attacked from two sides as independent natural-gas producers sought the first court tests of Order 174-A which places them under direct supervision of the FPC.

In separate suits, Stanolind Oil & Gas Co. and Ohio Oil Co. asked federal courts to prevent enforcement of the controversial order.

Stanolind filed suit in federal District Court here against the U. S. Government. The company is seeking a permanent injunction against enforcement of the order.

In New Orleans, Ohio Oil Co. sued the FPC directly. The petition, filed in Fifth Circuit Court of Appeals, seeks a review and stay of the order.

First test . . . The court cases represent a new strategy adopted by gas producers in their fight against government controls. Earlier, more than 100 producers had appealed to the FPC to reconsider its new policy.

The latest action by protesting companies is expected to bring the first court test of the FPC's recently proclaimed authority.

The U. S. Supreme Court recently refused to reconsider its decision in the Phillips Petroleum Co. case *(The Oil and Gas Journal, October 25, page 74)*. The Phillips ruling cleared the way for further controls by the FPC, but it pertained specifically to sales of gas going into interstate commerce and did not touch directly on all the other controls embodied in Order 174-A. The order itself has not been tested in court.

Outcome of the suits may affect some 4,000 independent producers who were brought under government control by the FPC ruling in regard to gas sold for interstate commerce. Although the deadline for filing applications for sale of gas has been moved from October 1 to December 1, the FPC has maintained its control on prices as of June 7 *(The Oil and Gas Journal, October 4, page 112)*.

Stanolind suit . . . In its petition, Stanolind Oil & Gas Co. alleges one section of the far-reaching order is unconstitutional in that it deprives the company of its property in violation of the Fifth Amendment.

Under Section 157.28, the company contends, Stanolind is forced to continue sales and deliveries of natural gas against its will. The company claims this amounts to confiscation of its property for public use without just compensation.

In addition to listing specific objections to three sections of Order 174-A, Stanolind alleges the entire order is so indefinite and uncertain that the company is unable to determine which of its gas sales are subject to FPC control.

The order imposes on Stanolind the duties and obligations of a public utility or common carrier when it actually is neither, the complaint alleges.

Section 157.23 exceeds the authority delegated to the FPC by requiring the company to seek certificates of convenience for the sale of its gas and by forcing the company to continue its sales until such certificates are issued, the petition states.

Stanolind also objects to Section 154.94, which it claims is unlawful in that it considers any clause in a contract that changes the price of gas as a change in rates.

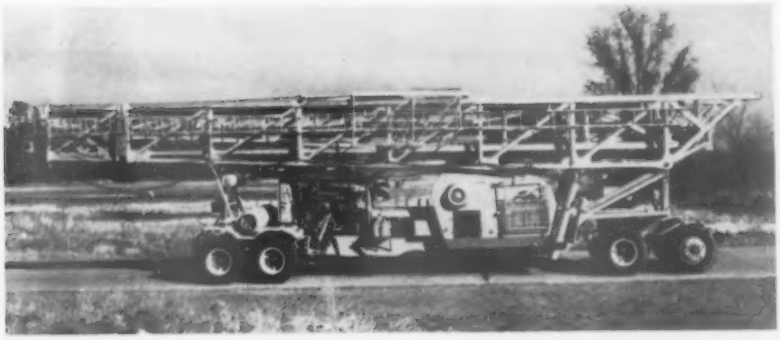
The company asks that the entire order be annulled.

The Stanolind suit was described by a company spokesman as "unorthodox" in that it is directed against the Government rather than the specific agency involved. This route was decided on because the company prefers to have the case heard in Oklahoma rather than in Washington and because a judgment against the FPC alone would not prevent the Attorney General from bringing enforcement proceedings.

Ohio suit . . . The petition filed in New Orleans also contends the order is unconstitutional in that the company is required to devote its property to public use without just compensation.

The order, according to the Ohio suit, violates provisions of the Natural Gas Act, the Administrative Procedure Act, and the FPC's own rules in that it was issued without notice and without a public hearing.

The company also contends that the provision prohibiting discontinuance of sales to interstate pipelines will interfere with the regulatory powers of states in which the gas is produced.



Aluminum Derrick Goes to Work

PAULS VALLEY, Okla.—The oil industry's first all-aluminum derrick is now on its initial location near here, performing well-servicing work.

The telescoping derrick is mounted on a mobile unit and is constructed of welded, hollow-section structural aluminum. It is rated at the same capacity as the steel derrick it replaces, but is 5,000 lb. lighter.

Ray's Well Servicing Co. of Pauls Valley, which bought the derrick as a part of the mobile unit, expects to use it up to its rated capacity—drilling to 5,000 ft. with 3½-in. drill pipe or servicing to 15,000 ft.

While the aluminum derrick costs slightly more than the standard steel derrick, it is expected that the cost can be reduced substantially as the technique of working aluminum becomes more familiar and as production volume increases.

Principal attraction of the aluminum construction is the weight saving. Franks Manufacturing Corp. of Tulsa, which built the derrick in conjunction with the Reynolds Metal Co., claims that a saving in excess of 40 per cent in weight can be effected by using aluminum. This means that a greater capacity well servicing unit can now be transported than was formerly possible under highway weight restrictions. This particular derrick extends to over 100 ft., but folds to less than 60 ft. over the vehicle.

In addition the aluminum is not subject to ordinary atmospheric corrosion and requires no paint.

Industry Briefs

LOS ANGELES. — Continental Oil Co. abandoned its 1 City of Hoquiam in Grays Harbor County, Washington, after drilling to 3,737 ft. The test, in 3-18n-10w, was Continental's fourth dry hole in Washington this year. The rig was moved southeast of Aberdeen, in 19-16n-8w, where hole was being made at 1 J. B. Erkenbrecher.

HOUSTON.—The International Oil Exposition to be held at the Coliseum here May 3-8, 1955, has contracted space to 150 exhibitors. Approximately two-thirds of the available exhibit space has been reserved.

EMERYVILLE, Calif. — Shell Development Co. will expand its laboratory and office facilities here by 50 per cent through the purchase of three buildings and four acres of adjoining land. The conversion of the property for research is expected to begin about April 1, 1955.

DALLAS.—Magnolia Petroleum Co. has purchased a three-place Bell Model 47G heiicopter to shuttle supervisory personnel and key equipment from near the Jefferson County airport to its drilling platform 25 miles away off Sabine, Tex., in the Gulf of Mexico. This is the first outright purchase of one of the craft by an oil company. Standard procedure is to lease or rent the copters from a commercial operator.

DALLAS. — Petroleum Branch of American Institute of Mining and Metallurgical Engineers has established the Cedric K. Ferguson medal to be awarded annually for professional achievement in petroleum engineering. The medal honors Cedric K. Ferguson, a former A.I.M.E. member, who died of polio at the age of 31 in August 1953. The medal will be awarded at the fall meeting of petroleum branch of A.I.M.E. to a member under 33 years old. The selection of the recipient will be based on a technical paper written by him during the year. Kenneth S. Ferguson, father of Cedric, accepted the first medal, which was awarded to his son.

ALASKA

Alaska in '55?

Interior delaying opening until talks with Congress

WASHINGTON. — It probably will be next year before from 20 million to 25 million acres of possible oil-bearing Alaskan land is opened for exploration.

Interior Department officials had hoped to open the land last summer, but now have decided to delay action until after the area is discussed with the Senate and House armed services committees of the new Congress.

The land in question runs across the northern part of Alaska, surrounding Naval Petroleum Reserve No. 4 on three sides. It was withdrawn by former President Roosevelt in 1942 when the Navy started its big exploration program to test the oil potentialities of the reserve and the adjacent area.

Following termination of the Navy's program last year, Interior officials began to consider lifting of the embargo on private development.

Alaskan interests have urged the opening of the lands, largely because of the discovery of substantial gas reserves in the Gubik field just outside the southeast corner of the naval reserve. It has been proposed to build a pipeline to carry the gas to Fairbanks and, eventually, Anchorage.

The possibility of opening of the reservation was disclosed by officials last June (*The Oil and Gas Journal, June 21, page 120*). The Naval Reserve is not included in the area to be opened up, but the congressional committees will be consulted because of their past interest in the matter of Alaskan oil.

Alaskan Agreement Made

SAN FRANCISCO.—Union Oil Co. of California and Ohio Oil Co. have taken option agreements on 55,000 acres on Kenai Peninsula in Alaska from a group represented by LeRoy H. Hines, a petroleum consultant here.

Kenai is across Cook Inlet from land that Shell Oil Co. is exploring and on which Havenstrite interests of Los Angeles are currently drilling below 4,000 ft.

Two other firms, Phillips Petroleum Co. and Alaska Oil Development Co., are presently drilling exploratory wells in this part of Alaska, and earlier this year, Standard Oil Co. of California entered a contract with Department of Interior to explore 750,000 acres of land near Kenai.

Pembina Outlet Finished

New crude line expected to spur development in Canada's biggest field; transportation costs to be cut 75 per cent

EDMONTON.—Pembina pipeline—perhaps the most important trunk line ever built in Canada—is scheduled for completion this week.

The 72-mile, 16-in. line will give Alberta's highly touted Pembina field its first pipeline outlet, moving crude to connections here with lines of Interprovincial Pipe Line Co. and Trans Mountain Oil Pipe Line Co. The new line is being built by Pembina Pipe Line Co., Ltd., Edmonton.

The line is expected to bring two things:

. . . **Accelerated development** of Pembina field, which currently has about 100 producers.

. . . **Lower transportation cost,** which is one of the reasons development in the field has been slow. The present cost of trucking crude from the field to Edmonton is about $1 a barrel. It is estimated the pipeline will move the crude to the Interprovincial and Trans Mountain connections here for one-fourth this cost.

The line will have a maximum throughput of 150,000 bbl. daily. What is expected to be Alberta's largest gathering system also is being laid in the field. The system will total about 400 miles of pipe ranging in diameter from 3 to 12 in. The system will be extended with growth of the field.

Mannix, Ltd., Edmonton, 25 per cent owner of the line, is contractor. The biggest stockholder in the new line is Dome Exploration (Western), Ltd., which holds 26 per cent of the stock. The remaining 49 per cent has been offered to producers in the field.

The field . . . Pembina was discovered in July 1953 and the first well was brought in by a team headed by Socony-Vacuum Oil of Canada, Ltd. By the end of the year, there were only six producers in the field, but many observers declared the field was the biggest thing to hit Canada's oil industry.

This opinion was backed with cash from several of the large oil companies last January at the government's first auction of oil rights in Pembina. The auction netted $28.5 million. Texaco Exploration Co. paid as high as $141 an acre while Imperial Oil, Ltd., paid up to $120 an acre.

In addition to lack of a pipeline outlet, development of Pembina has been hampered by the muskeg, heavy rains, and lack of roads *(The Oil and Gas Journal, June 28, page 74).*

Production in Pembina is from the Cardium sand, Alberta's first such production. The average well cost is about $90,000.

The future? . . . In regard to present production, one oil company official pointed out the 100 Pembina producers are located in 250,000 acres of proven oil land without a dry hole in the area.

"You can say that in an area of 400 sq. miles, there are 100 completed wells in an area which with 80-acre spacing could accommodate 3,300 wells. And two sides of the field, the south and west, have not been established. Nobody knows how big the field will be."

Group Acquires Antone

TORONTO.—A group headed by Lowell M. Birrell, New York financier, has acquired control of Antone Petroleums, Ltd., Toronto.

Antone has oil production in Texas and holds acreage in North Dakota, Wyoming, and Canada. The company also has proven gas reserves in Pouce Coupe and Kessler areas in Canada.

CROSSING the swift Niagara River took 9 hours.

Natural Gas Comes to Toronto

TORONTO.—This metropolitan center is making the big switch from manufactured to natural gas.

The change started last week after completion of a 101-mile, 20-in. pipeline from near Niagara Falls, N. Y., to Toronto. The line was the last link in a transmission system that carries the gas from fields in Texas and Louisiana. The line connects with Tennessee Gas Transmission Co. lines in New York.

Trans-Canada Pipe Lines, Ltd., built 80 miles of the line and Consumers' Gas Co. of Toronto 21 miles. The line will have a capacity of 115,000,000 cubic feet of gas daily. It cost $10 million.

Consumers' Gas is expected to sell the Texas and Louisiana gas for about 3 years, then switch to natural gas moving through Trans-Canada's main trunk line from Alberta. The 80-mile section running into New York may be used to export Canadian gas into New York once Trans-Canada starts moving the Alberta gas.

It took approximately 4 months to complete the line. The toughest natural barrier during the construction was crossing the swift Niagara River.

Consumers' Gas is spending about $3½ million to convert its facilities from coal-derived gas to natural gas. The conversion is being conducted by about 650 workmen and is expected to be completed throughout the area by February 19.

Refinery Sold

Husky buys Moose Jaw plant; expansion slated

MOOSE JAW, Sask. — Moose Jaw Refineries, Ltd., operator of a 2,000-bbl. daily refinery here, has been purchased by Husky Oil & Refining, Ltd. It is the second refinery purchased by Husky in 2 weeks.

Husky officials revealed plans to expand the capacity of the refinery to 5,000 bbl. daily.

The refinery here was a subsidiary of Trans Empire Oils, Ltd. John D. Boyd, Trans Empire president, said his company sold the refinery so that it could retire from the refining field and concentrate on production.

Purchase of the plant brings to three the number of refineries owned by Husky. Last week the company purchased Riverlake Oils, Ltd., operator of a 4,000-bbl. daily refinery at Fort William, Ont. Husky also plans to expand the capacity of this plant to 5,000 bbl. daily. Husky's third refinery is a 8,500-bbl. daily plant at Lloydminster.

The refinery here was built shortly after World War II by a group of Saskatchewan business men. Trans Empire purchased the plant in 1951, expanding the capacity from 1,000 to 2,000 bbl. daily.

L.P.G. Line Planned

Winnipeg firm will import from Signal's Tioga plant

WINNIPEG, Man.—Plans for a $20,000,000 L.P.G. pipeline system to transport North Dakota butane and propane from Tioga to Winnipeg were announced last week by W. H. Davey, president and general manager of Winnipeg & Central Gas Co.

Davey said only final details remain in a contract to purchase butane and propane from Signal Oil & Gas Co.'s Tioga gasoline plant, and with Deep Rock Gas Co. to build the $5 million North Dakota leg of the pipeline. Construction will start in the spring, he said.

Size and route of the line has not been determined, Davey said, but "we're thinking of a small line, 4, 6 or 8 in. It probably will run from Estevan, Sask., eastward through Brandon, Minnedosa, Neepawa, and Portage La Prairie in Manitoba."

Big demand . . . Winnipeg & Central, now serving the Manitoba capital city with propane-air gas from propane transported by rail from Oklahoma, recently purchased a number of L.P.G. companies in Manitoba and Saskatchewan.

"We can use all the L.P.G. Signal has at Tioga," Davey said. "We even fly it up north."

Davey has signed a contract with Trans-Canada Pipe Lines, Ltd., to buy natural gas when the proposed line reaches Winnipeg in October 1955. Tioga L.P.G. would be used for peak-shaving, he said.

Signal has had difficulty finding markets in North Dakota and the nearby area, particularly for butane and during the summer.

Davey said the line may also be employed to transport gasoline from Winnipeg to Manitoba, but said initially such deliveries will not be possible since the line is planned as a private carrier. He added it probably will later be declared a common carrier.

ROCKY MOUNTAIN

Refinery Planned

South Dakota chosen as site of 3,000-bbl. plant

RAPID CITY, S. D.—South Dakota, the nation's twenty-ninth producing state, will soon go back on active status as a refining state.

Great Plains Refinery & Development Co., Rapid City, announced plans last week to build a 3,000-bbl. refinery here. Arthur Gordon, president of recently organized Great Plains, said that he expects the refinery to cost approximately $3,000,000.

Radak Oil Co., a firm which Gordon also heads, has first option on sale of crude to the refinery. Radak has production in Weston County, Wyoming. Great Plains will also purchase additional crude from other fields in Wyoming and eastern Montana.

While Gordon gave no details of what kind of units the company would construct, he did say that it would produce a gasoline in the 92-98-octane range.

The Oil and Gas Journal's annual refinery survey shows that South Dakota now has three refineries, all currently closed. They are: Hot Springs Refining Co., Hot Springs; Rex Oil Refining Co., Rapid City; and How Kola Refining Co., Sturgis.

However, Great Plains will be the first in the state of significant capacity. Hot Springs and Rex were 200-bbl. refineries, while How Kola had a 130-bbl. capacity.

Deep Wildcat Plans Dropped

CASPER.—Plans to drill one of the deepest wildcats ever scheduled in the Rocky Mountains apparently have been abandoned in favor of completing the well as a commercial gas producer.

El Paso Natural Gas Co., Continental Oil Co., and Malco Refineries, Inc., have reached a total depth of 9,676 ft. at their originally scheduled 15,000-ft. test on the Pinedale structure in Sublette County, Wyoming.

The wildcat reported gas shows below 8,500 ft. The best recovery was 170 M.c.f. per day. The test is along the route of the proposed Pacific Northwest Pipeline Corp. gas line from San Juan basin to Washington State.

Pinedale is one of Wyoming's largest structures. A unit of 90,000 acres, covering most of the big structure, was approved earlier this year.

Crude-Line Plans Revised

CHEYENNE, Wyo.—Cheyenne Valley Pipe Line Co. has dropped plans to build a 58-mile, 10-in. crude line in favor of laying a line slightly more than twice the length of the original proposal.

The revised plans call for a 118-mile, 10-in. line from the Cheyenne River area of Weston County to a connection with Platte pipeline at Fort Laramie, Wyo. This proposal would furnish a second outlet for the high gravity crude production from the southwestern portions of the Clareton trend in Weston and Niobrara counties. Plains Pipe Line Co. currently serves the area.

Cheyenne Valley originally planned a line from Lance Creek to Fort Laramie *(The Oil and Gas Journal, August 23, page 107)*. An application to build the expanded project will be heard December 16 by the Wyoming Public Service Commission. The line will cost an estimated $2,800,000.

The line's principal backers are H. O. English, Casper, Wyo., and Maurice Yates, Salt Lake City, who have told the commission that construction would start 60 days after the commission's approval and would be completed in 90 days.

Shell Has Strike In Utah

SALT LAKE CITY.—Shell Oil Co. apparently has made a major oil discovery in San Juan County, Southeast Utah.

According to S. F. Bowlby, vice president, the company's 2 Desert Creek in an 18-hour production test flowed 40°-gravity crude at a 1,128-bbl. daily

rate. Production, including a 2.8 per cent water cut, was from the interval at 5,244-5,320 ft. The well had been perforated and acidized previously.

The wildcat, located about 15 miles southeast of Bluff, Utah, is about ¾-mile northeast of Shell 1 Desert Creek, abandoned last July as a dry hole.

Big Lines Tested

New systems will serve Rocky Mountain fields

DENVER.—Two important outlets for Rocky Mountain crude oil are nearing completion.

Filling of Western Pipe Line Co.'s new large-diameter line started last week at Laton, Kans. Almost simultaneously, initial shipment of 25,000 bbl. of crude oil started through completed sections of the Arapahoe pipeline.

The Western line will consist of 20, 22, and 24-in. pipe and will stretch from Fort Laramie, Wyo., to Freeman, Mo., a distance of about 625 miles. Only a few segments of the line remain to be laid.

The carrier, with an initial capacity of 178,000 bbl. daily, will transport crude oil from Montana, Wyoming, Colorado, and Western Kansas to Midwest refineries. The line is designed to handle more than 200,000 bbl. per day with addition of more pump stations.

Western Pipe Line Co. is a subsidiary of Service Pipe Line Co.

Arapahoe Pipe Line Co.'s system will have an initial capacity of 80,000 bbl. daily. It will serve the Denver-Julesburg basin and western Kansas.

Put in service were two spreads totaling 168 miles between Schurr Station and Humboldt, Kans., eastern terminus of the line. When completed, the 18 and 20-in. crude carrier, jointly owned by Pure Oil Co. and Sinclair Pipe Line Co., will extend 479 miles from Merino, Colo., to a junction with Sinclair's 24-in. system to refineries in the Chicago area.

The entire line is scheduled to be put in service before the end of the year.

Denver-Julesburg Leads

DENVER. — The Denver-Julesburg basin, for 3 years the leader in Rocky Mountain discovery success, is leading the region once again in 1954. Wildcatters have come up with 46 oil and 12 gas strikes in the first 10 months of the year.

This year's discoveries are marked by an unusual record of high potentials in the basin. The strikes have extended the basin's producing limits to the north, east, and south. Currently there are more than a dozen wildcats in the busy basin.

Of the six prospects testing in western Nebraska, Rex Petroleum Co. 1 Johnson Estate in Banner County is the most important. The wildcat is still swabbing after recovering oil at the rate of 110 bbl. per day. Banner County is one of the most active areas in this part of the basin.

Frontier Refining Co. 1 Frasco-2, Logan County, Colorado, is shut in after flowing 235 bbl. of oil in 4 hours. Another good strike in Colorado is S. D. Johnson and Cosden Petroleum Co.'s 1 Rosener in Adams County. This wildcat is going on pump after swabbing 246 bbl. of oil in 10 hours.

Extraction Plant to Open

DENVER.—A gasoline plant and gas-gathering system being constructed 30 miles south of Brush, Colo., under a seven-company agreement will be completed in mid-December or early in 1955.

Continental Oil Co., which will operate the plant, said the installation, originally slated as a compressor plant, is being expanded into a complete extraction plant. The plant will process gas from Little Beaver, Badger Creek, and Bobcat oil fields of Washington and Adams counties. It will have a capacity of 10,000 M.c.f. daily, producing about 70,000 gal. of gasoline, propane, and butane.

Associated with Continental in the project are Sinclair Oil & Gas Co., Denver Basin Oil Co., Col-Tex Oil, Inc., Lyon Oil Co., J. A. McRae, Ltd., and Triangle J Oil Co. Norman Compton of Continental's Denver office will be plant superintendent.

Products Line Being Filled

CHEYENNE, Wyo.—Wyoming-Nebraska Pipeline Co.'s 220-mile, 6-in. products line from Cheyenne to North Platte, Neb., is being filled.

The line has a daily capacity of 8,000 bbl. from here to the Sidney, Neb., terminal and 6,000 bbl. from Sidney to North Platte.

Wyoming-Nebraska Pipeline is a subsidiary of Frontier Refining Co., operator of a 15,000-bbl. daily refinery 5 miles west of here.

The line was constructed by a joint venture formed by Gulf Interstate Engineering Co., Houston; H. C. Price Co., Bartlesville, Okla., contractors; and Houston Contracting Co. The engineering firm is a subsidiary of Gulf Interstate Gas Co. The Wyoming-Nebraska line is its first project.

WEST COAST

Long Beach Active

Competition high in new prolific Airport field

LONG BEACH.—The new Airport field opened by The Texas Co. in the shadow of famous old Signal Hill has produced the most competitive oil play in California.

Five rigs are at work there, and the number will go higher as activity spreads out from Cherry Avenue, the "supply row" of Long Beach.

Latest completion, the seventh for the 8,500-ft. pool, was Hancock Oil Co. 52 Signal. With 1,400 ft. of perforations open to the Miocene oil sand, the well flowed 32°-gravity crude at a 3,000-bbl. daily rate while cleaning up. Most other completions were for approximately 600 bbl. daily through ¼-in. chokes.

Because of the thick pay section and predicted high ultimate recoveries, development of the town-lot portion will be rapid and tests will be closely spaced.

Since the Division of Oil and Gas has declared the discovery a new field, state well-spacing laws will limit drilling to one well per acre.

Texaco holds a 1,040-acre lease on airport and adjacent city lands, but activity to date has been along the western boundary.

Hydrogen Line Opening Near

SAN FRANCISCO.—A 11½-mile pipeline between Shell Oil Co.'s Martinez refinery and Shell Chemical Corp.'s ammonia plant at Pittsburg is nearing completion. The 4-in. line will handle excess hydrogen from a recently completed Platformer at Martinez.

At the chemical plant, the line will be equipped with an automatic shutoff which will cut in in case of a line failure or other emergencies. Automatic equipment also will regulate proportioning and mixing of the Platformer hydrogen with that produced from natural gas at Pittsburg.

Hyperformer On Schedule

LONG BEACH.—Construction on the 1,500-bbl. Hyperformer being built here for Calstate Refining Co. is on schedule, with completion expected about the first of the year.

The unit, first commercial installation of the Union Oil Co. licensed process, will include catalyst-lift facilities which accomplish regeneration during the upward catalyst movement.

1955 Congressional Calendar:

Will Imports Be Controlled?

WASHINGTON. — The oil-import problem was racked up last week as one of the major issues to be pressed before the new Congress next year.

Import control will come up in one of two ways—either by recommendation of the Cabinet Committee on Energy Supplies and Resources Policy or, by appeal to the House ways and means committee.

The cabinet committee is due to submit its report and recommendations to President Eisenhower in 2 weeks. J. Ed Warren, one-time independent producer, is directing the committee's oil study. Warren is thoroughly versed in the import situation and his report may demonstrate the need for reduction of imports.

Whether the committee itself will make such a recommendation to the President is one question. Whether the President, who is committed to the continued elimination of tariff barriers and fully reciprocal international trade, will make such a recommendation to Congress is another question.

The President's recommendations on oil imports and other aspects of international trade will go to Congress early next year. The House committee then will take up the question of extending the Reciprocal Trade Agreements Act, now due to expire next June 12, and that's where the fight will begin.

Who will fight . . . When the reciprocal trade law was up for extension before the committee last year, Rep. Richard M. Simpson of Pennsylvania, currently second-ranking member, but third-ranking member of the minority next session, made a strong and almost-successful fight for import controls. This was one of the factors in the committee's decision to limit extension to 1 year instead of the 3 years asked by the administration.

Domestic-oil producers and the coal industry will lead the fight for controls. The producers want limitations on imports to keep the industry strong and healthy. The coal operators want them as a way of regaining lost markets which they contend have been taken over by imported residual-fuel oil.

I.P.A.A. stand . . . Russell B. Brown, general counsel of the Independent Petroleum Association of America, declared in a report to the membership following the association's recent Tulsa meeting that "the lines are now drawn, pointing very directly to a serious legislative fight on the question of imports."

Review of the situation at Tulsa, Brown said, showed that "industry satesmanship had failed, that administrative correction had not been obtained, and that the remaining course of legislative relief was now clearly the only realistic choice."

"None of the five importing companies show in their statements to the cabinet committee that their production abroad now constitutes well over half of their total production and that their earnings have the same relative position," Brown charged.

Gas Prices Argued

New regulations on rates being considered by FPC

WASHINGTON.—Automatic escalation and "favored nation" clauses in gas-sales contracts between producers and pipelines were variously described before the Federal Power Commission last week as essential to the well-being of the natural-gas industry and as a restraint on competition and a source of increased consumer rates.

The former position was maintained by independent producers and pipeline companies, the latter by public service commissions of consuming states. The opposing views were described in oral arguments on which the commission will decide whether to adopt rules concerning such clauses.

The FPC disclosed it was interested in automatic price-increase provisions before the Supreme Court decision in the Phillips case.

Policy changed . . . The commission last May emphasized that its study of sales contracts would be directed at determining whether provisions for automatic price increases had any reasonable relation to the economics of production, gathering, or transportation. At that time the FPC recognized that Congress had provided the Natural Gas Act should not apply to production or gathering.

Under the Phillips decision this limitation has been eliminated. It is considered possible, now, that any restrictions the FPC may impose on price increases may be embodied in regulations concerning the method and standards to be used in regulating producers' prices.

Opposing views . . . In oral argument, spokesmen for the natural-gas producers contended restrictive action on the price-increase clauses would result in interference with the law of supply and demand. They claimed it would result in the abrogation of contracts already approved by the commission in certificates issued to the pipelines.

Pipeline officials argued that since long-term contracts are required under the FPC's regulations for an adequate gas supply to be assured before a line is built, it is only fair to the producer to recognize the increased costs of gas that may occur during the life of the contracts.

Public Service Commission representatives, however, asserted that producers' prices should be based upon actual cost experience. They charged that favored-nation clauses made "collusive sales" possible and could destroy competition in a gas field.

Price Ruling Due

Supreme Court to decide authority over gas rates

WASHINGTON. — Oklahoma's authority to regulate the price of processed gas sold for immediate shipment out of the state will be decided by the Supreme Court.

Appeals of the Natural Gas Pipeline Co. of America from a decision of the Oklahoma Supreme Court upholding a state order setting a minimum price of 9.8262 cents per M.c.f. on gas from the Guymon-Hugoton field were accepted for review last week.

The Oklahoma court upheld the state's right to set minimum prices as being within its power to eliminate waste and conserve natural gas. The company contended the order interfered with interstate commerce and that the regulation of gas for interstate shipment is a responsibility of the Federal Power Commission.

The company bought gas from the Panoma Corp. in Texas County, Oklahoma, after it had been processed. It contended the gas became its property when it entered its pipelines for transport to out-of-state markets and protested the effect of the order was to "transfer" millions of dollars from consumers to gas producers.

The 1952 court order increasing the minimum price also specified for the first time that it should apply to processed as well as natural gas.

Another view outlined on . . .

How Atom Will Affect Oil

ABILENE, Tex. — Oil men were warned here last week not to overlook the threat of atomic energy—which may in the next decade or two become much more serious than present import, Federal Power Commission, and other problems.

Frank B. Conselman, speaking at the twenty-first annual meeting of the West Central Texas Oil and Gas Association, told the approximate 250 oil men attending that there is an unmistakable competitive situation shaping up between conventional and nuclear fuels.

"It is not whether, it is when," the Abilene consulting geologist said.

Conselman's views are in contrast with those of L. G. Weeks, chief geologist for Standard Oil Co. (N. J.), who outlined oil and atomic energy at another recent Texas meeting *(The Oil and Gas Journal, November 8, page 124)*. Weeks feels oil and the atom will be "economic partners" more than competitors.

Conselman quoted Dr. George C. Manov, adviser to the Atomic Energy Commission, as saying recently that "atomic energy and petroleum will not compete but will, rather, complement each other in the years ahead."

"This 'complementing' sounds suspiciously like 'supplementing,' which is what imports are supposed to do instead of supplanting domestic crude oil," said Conselman. "At the present rate of increase of imports, there is some danger that domestic producers may be 'supplemented' out of business."

Figures show that oil and gas will be facing a powerful competitor in atomic power, he said. One pound of nuclear fuel can generate more than 2,600,000 times the explosive force of the equivalent amount of oil, gas, or coal. He added that minable deposits of uranium are estimated to contain 20 to 25 times the energy of all known world reserves of oil, gas, and coal combined.

What it means . . . The development of peacetime-atomic power will require a big adjustment in the oil and gas industry, Conselman said.

According to an AEC official, Conselman said, the next 20 years will be a transitional period for atomic energy dedicated to cutting costs. Prior to 1975, conventional fuels will be complemented by nuclear fuels. The latter will furnish not more than 10 per cent of total domestic electric power requirements. Other authorities, however, place atomic energy's share of all new power at 11 per cent in the next 10 years.

Atomic energy probably will not become competitive with oil and gas within the payout period of present wells, Conselman said, although no one can say definitely.

Wildcat Hits

Texaco finds Ellenburger 8 miles north of Odessa

ODESSA, Tex.—A flow of oil on drill-stem test at a wildcat 8 miles north of here indicates the presence of another Ellenburger-producing structure on the northwest-southeast trend developing on the eastern flank of Central basin platform. Its initial heavy flow, estimated at 50-100 bbl. hourly, also promised another find of the magnitude of fields like War-San, Virey, and Headlee.

The new well is The Texas Co. 1 Sallie Ratliff, in Section 25, Block 42, T1S, T&P Survey. Tentative top of the Ellenburger was 13,560 ft., minus datum point of 10,548 ft. This top is low to dry holes to the northwest, and is several feet lower than the water table in Headlee field, pointing to faulting in the area, or a separate and new structure.

On drill-stem test to 13,585 ft. the well showed gas and recovered a show of oil. Coring ahead to 13,605 ft. it recovered additional dolomite with oil shows, and a test at 13,585-13,605 ft. blew gas in 37 minutes and flowed oil in 115 minutes. Field sources said the flow was too heavy for available separators to handle, and it had to be turned into pits for 15 minutes. Following the test, drilling continued soft and with oil stains, to 13,625 ft., where another test was scheduled.

Texaco's 1 Ratliff is the first link between Headlee and similar production in Midland Farms field, 16 miles to the northwest, where 15 Ellenburger wells produced 3,000 bbl. daily in October.

Two Floods Planned

Projects in Lindemann, Welch fields approved

AUSTIN.—Two water floods, each expected to recover more than 1,000,000 bbl. of additional oil, were approved by the Texas Railroad Commission here last week.

The projects will be carried out in Welch field of Dawson County by Cities Service Oil Co. and Lindemann field, Runnels County, by American Trading & Production Corp.

Cities Service estimates it will produce an extra 1,644,000 bbl. of oil in a flood of the 4,860-ft. San Andres reservoir underlying its 560-acre Kirkpatrick lease in Welch field.

Production from this lease is considered settled, with 9 of its 14 producers classed as marginal wells. Four of these wells will be converted to input wells and about 400 to 600 bbl. of water daily injected through each at a pressure of about 1,000 psi. Salt water obtained from the Fusselman at 11,960 ft. will be injected through a closed-type system and with a 40-acre, five-spot injection pattern.

American Trading & Production will try a pilot operation in the 2,475-ft. McMillan sand in Lindemann field. The company received permission to expand the pilot into a lease-wide operation if it performs satisfactorily.

The company will inject 500 to 750 bbl. of water daily at a pressure of 100 psi. into the McMillan through one input well. Injection fluid will be produced salt water plus some additional from the 1,200-ft. Coleman Junction formation.

American Trading & Production thinks it will produce 1,000,000 bbl. of oil over ultimate primary production if a full-scale flood is undertaken. The 2½-year-old lease has 11 wells producing about 26 bbl. daily each.

Australian Area Released

Interest shifts across continent to Queensland as gas is reported in new test; Lucky Strike spuds wildcat

WEST AUSTRALIAN PETROLEUM PTY., LTD., is turning back to Australian Government two of its six permit areas totaling 108,000 sq. miles.

The company has made official application to the West Australian Government for renewal of four other permits comprising the greater part of the approximately 325,000 sq. miles over which it has held exploration rights.

West Australian Petroleum, or WAPET, 80 per cent owned by Caltex, made Australia's first commercial oil discovery in November 1953 in the Exmouth Gulf area. The discovery tested about 550 bbl. daily, but the first stepout and another test on a nearby structure were dry.

In Perth, J. W. Thomas, manager of the company, said the exploration program for 1955 provided for the expenditure of about $9,000,000. He said this total would be doubled in the event of further oil discoveries.

It also was announced that the company would extend its geological reconnaissance to Barrow Island, 45 miles southwest of Monte Bello Islands, in the near future.

It has been speculated that Shell Co. of Australia, Ltd., might seek part of the concession originally held by WAPET *(The Oil and Gas Journal, September 27, page 62).*

East Australia . . . Across the continent in Queensland, Australasian Oil Exploration, Ltd., was reported to have a gas show at about 4,500 ft. in its Reid's Dome well. The test, located near Springsure about 150 miles west of Rockhampton, is on a concession covering 1,800 sq. miles.

An earlier flow of gas was reported in the Australasian well at about 500 ft. *(The Oil and Gas Journal, September 27, page 62).* A flurry of excitement surrounded the test last week when unofficial reports indicated oil had been found in commercial quantities.

About 250 miles east and slightly south of the Australasian well, Lucky Strike Drilling Co., Tulsa, spudded its first wildcat in Queensland. The test, projected to 11,000 ft., is near Maryborough about 12 miles inland from Hervey Bay. It is being drilled by Oil Drilling & Exploration, Ltd., Sydney, which has a 20 per cent interest in the Lucky Strike concession *(The Oil and Gas Journal, August 23, page 112).*

The concession, originally covering 5,700 sq. miles, or 3,648,000 acres, has been reduced to about 2,500,000 acres. Under terms of the concession, a 2,000-sq.-mile area was released back to the government last spring, and an additional 1,500 sq. miles will be released next year.

Gas Line Finished

New carrier will help move coke-oven product to Paris

GAZ DE FRANCE, representing the nationalized French gas industry, has completed the major part of a 380-mile pipeline system which will move surplus coke-oven gas to Paris from the coal and steel-producing regions of northeastern France.

The gas is compressed to about 850 psi. at points of origin and delivered through two main feeder lines—one from northern Lorraine and the other from the Saar—to Blenod, a town about 200 miles east of Paris. From this point, a 12-in. transmission main extends into the French capital.

The system will transport about 56,000,000 cu. ft. of gas. A booster station eventually will be constructed at Bettancourt about half way between Blenod and Paris making increased deliveries possible.

Background . . . The Gaz de France line is the only important gas pipeline system in France other than that operated by the French government company, Regie Autonome des Petroles, in southwestern France. R.A.P. delivers natural gas from St. Marcet field through lines extending to Bordeaux and other points.

The French National Assembly in 1952 passed a bill authorizing the Gaz de France pipeline system to be carried out as an all-French project without Marshall Plan aid.

The new line will supply the Paris area as well as a number of towns and villages along the route. It will make possible the closing of the more obsolete manufactured gas plants in Paris and will improve the competitive position of the Lorraine among foreign gas producers such as those in the Ruhr Basin which delivers gas as far as Berlin through the network of the Ruhrgas company pipelines.

Formosan Gas Search Pushed

China Petroleum Corp. is conducting an offset-drilling program to define its newly discovered gas reservoir in the South Chinshui field in northwestern Formosa.

Gas reserves established thus far are conservatively estimated at 3 billion cubic feet. The commercial discovery was made last July in C.P.C.'s Chinshui 49 well. The gas was found in the untested first A zone, which is about 60 ft. thick and consists of highly porous and permeable sandstone with thin shale interbeds. The zone is a member of the lower Kueichulin formation of Upper Miocene age.

Initial production of the well was 500,000 cubic feet daily, from a depth of about 1,800 ft. The production, though small according to world standards, is important in helping meet domestic demand in Formosa.

Pemex Finishes Crude Line

Petroleos Mexicanos has completed a 25-mile 14-in. pipeline to deliver crude oil from the new Miguel Hidalgo field near Tecolutla northwest into an existing line leading to the Poza Rica refinery.

The state company also has brought in the second well in the new field which was Mexico's first light-oil discovery in a number of years. Miguel Hidalgo 2 had results similar to those in the discovery, although it was completed about 45 ft. deeper.

The discovery was brought in last August at 7,685 ft., testing 3,500 bbl. daily of 31°-gravity crude. With the pipeline outlet now completed, these first two wells in the field are expected to be produced at about 2,000 bbl. daily each.

Petrobras Contract Signed

Drilling & Exploration Co., Inc. (Nevada) will continue to provide technical advice and supervision in drilling and production for the Brazilian Government's oil activities, now controlled by Petrobras.

A 2-year contract along this line was signed recently in Rio de Janeiro by J. E. Brantly, Jr., vice president of Drilling & Exploration, and Col. Arthur Levy, president of Petrobras.

Drilexco worked with Petrobras' pre-

decessor agency, Conselho Nacional do Petroleo, under a similar contract for more than 15 years and had been directly concerned with most phases of Brazilian oil activity since the initial discovery in the State of Bahia in 1939.

R. L. Rose, recently elected president of Drilling & Exploration Co., Inc. (Nevada) is planning to visit the company's operations in Brazil in the near future. Rose's headquarters are in Los Angeles.

British Field Extended

Commercial production has been obtained in a third well at Plungar, Leicestershire, England, where D'Arcy Exploration Co., Ltd., discovered a small field about a year ago.

Plungar 6 on short test produced at a rate of 12 tons, or about 85 bbl., daily from 2,853 ft., but this is expected to settle down to 2 to 3 tons, or 15 to 20 bbl., daily on steady production. The original discovery well has been producing about 15 bbl. daily, supplemented by the small output from No. 2. The next three wells drilled were dry, but the results of No. 6 are more encouraging. Several other locations have been made at Plungar.

Continuing its exploration elsewhere in Britain, D'Arcy has made location for a new wildcat at Faringdon, Berkshire. The company said it would move a rig from Bottesford where another shallow exploratory hole was drilled recently.

Oil's Hard to Find in Peru . . .

INTERNATIONAL PETROLEUM CO., LTD., has abandoned its Venturosa 10-X-1 wildcat, the twelfth dry hole drilled in the Sechura Desert of coastal Peru since the country was opened to new concessions under its 1952 oil law.

The Venturosa 10 well, in the southern part of the Sechura, was drilled to 5,836 ft. It was the fifth unsuccessful Sechura test drilled by International *(The Oil and Gas Journal, October 25, page 85).*

Drilling continued at about 4,900 ft. at the other current Sechura wildcat, Huaca 1 of Union Oil Co. of California. Union, which obtained its acreage in the Sechura by acquiring concessions originally granted to Conorada Petroleum Corp., has drilled five dusters.

To the north, in the region of Peru's existing producing fields, Douglas Oil Co. of California is reported drilling at about 2,000 ft. at its D-5 test. Peruvian Pacific is below 6,000 ft. at Tablazo 2-1, its third well on acreage held under contract with the government company, Empresa Petrolera Fiscal. Peruvian Pacific (Cities Service and Richfield) had shows at around 2,200 ft., and these are to be tested after the well reaches final depth.

. . . But Not All Wells Are Dry

PERU has one of the world's oldest active oil wells—a 545-ft. hole that has been producing more than 65 years.

Although it has set no great production record, the well yielded its 80,000th barrel of crude oil last month.

The long-time producer is International Petroleum Co., Ltd., 8, located in the old La Brea-Parinas concession.

Drilled in just 11 days, the well started producing November 13, 1889, and has been a producer continuously since then. Its life span has been two to three times the average for oil wells in the United States.

The historic well started producing only 2 years after the first oil producer was drilled in Texas and 8 years before Indian Territory (Oklahoma) had its first oil well. Never a prolific producer, the Peruvian well now yields approximately 30 bbl. of oil monthly.

International Petroleum is an affiliate of Standard Oil Co. (N. J.).

International Briefs

Carl Deilmann, German oil operator, has extended his exploratory work in Thrace into the Turkish part of this region. Deilmann Montan, GmbH., has been granted an exploration permit covering Turkish Thrace (the European part of Turkey). Deilmann has for some time been engaged in gravity-meter and seismograph work in the Greek part of Thrace through a contract with the Greek company, Ilios, which holds the concession.

Shell Co. of Ceylon, Ltd., is studying the feasibility of constructing a refinery in Ceylon. Hendala, 6 miles from Colombo, was regarded as the most likely location for the plant which would be Ceylon's first oil refinery. Shell of Ceylon is owned by Consolidated Petroleum Co., Ltd., which is controlled jointly by Royal Dutch-Shell and Anglo-Iranian Oil Co., Ltd.

A 1,500-bbl. per stream day Platformer, the fourth Platformer unit completed in Japan, has been placed in operation at the Mitsubishi Oil Co. refinery at Kawasaki. The unit was designed, engineered, and licensed by Universal Oil Products Co., and built by the Japan Gasoline Co. It is a major part of a general expansion at the Kawasaki refinery.

Taiwan Fertilizer, Ltd., has let contract to Hydrocarbon Research, Inc., for construction at Nankong, near Taipeh, of a plant which, starting from coke, will produce 150 metric tons daily of ammonia and convert this to 260 metric tons daily of urea. Ammonia plant design was by H.R.I. The urea facilities will use the Inventa urea process as licensed by Vulcan Copper & Supply Co., Cincinnati. Funds for the purchase of the equipment and the engineering services are being provided by the Foreign Operations Administration. H.R.I. will be responsible for design, procurement, and supervision of construction and operation.

A.P.I. PAPERS . . .

A section devoted to the principal papers presented at Chicago

Filtering Is Good Business

Survey shows products pipelines are thoroughly sold on need for adequate filtering program to insure cleanliness

by W. G. Horstman and Ivy M. Parker

RESULTS of a survey of products-pipeline filtering practices show that filtering is necessary to protect pumping and metering equipment against damage and wear, and to control sediment in products.

Corrosion control is practiced to minimize quantity of sediment to be removed. This control is effected through good inhibitor programs using either water or oil-soluble inhibitors, or by dehydration of product.

The range in filtering equipment varies from scale traps to very fine screens or fabric filter mediums.

Survey information was compiled on 53 pipelines, reported by 25 companies.

Water removal . . . Pipeline filtration consists of water removal, scale separation for protection of pumps, and fines filtration for protection of meters and quality of product.

Removal of free water is essential at input stations for control of internal corrosion. This water may be transferred from refinery tankage and water cargo vessels such as barges and tankers, or may collect in floating-roof tanks during rainstorms. Proper settling periods and water drawoff on tanks should take care of a large portion of this water, but not all. Hence, a number of pipelines, including some of those operating dehydration systems, have installed water separators at input stations.

It is necessary to have some protection for pumps to protect them against large quantities of scale and extraneous material such as nuts and bolts. In starting up a new line large quantities of mill scale can make this a major filtration job. The inhibitor program may influence the quantity of material to be handled.

For example, Fig. 1 shows the very large quantity of scale removed from an 18-in. line where buildup of inhibitor concentration was very low. Fig. 2 shows a corresponding 14-in. line where inhibitor concentration was built up very quickly. As the inhibitor program improved, the 18-in. line is now in as good condition as the 14-in.

Finer filtration is necessary for meter protection and control of sediment in product. In general, the better the filtration, the longer the meter life should be. In any case the filter medium must

Authors are associated with Plantation Pipe Line Co., Atlanta. Paper presented at annual meeting, A.P.I., Chicago, November 9, 1954.

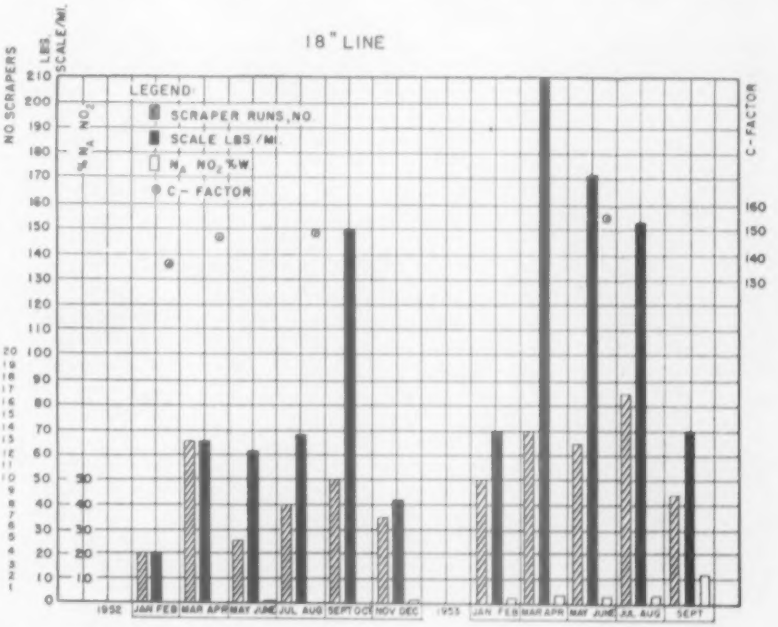


Fig. 1—Variations in scale collection, scrapers required, and C-factor of 18-in. line as inhibitor concentration increased.

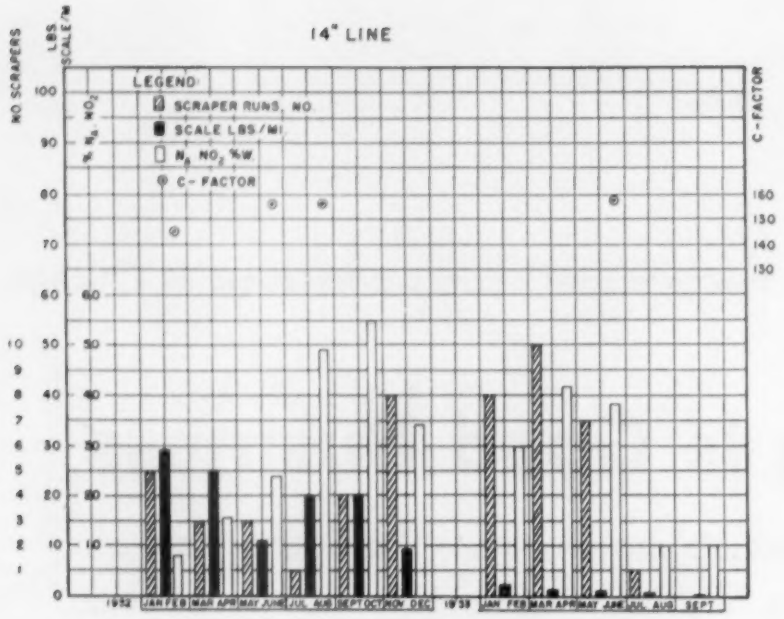

14" LINE
NO SCRAPERS
LBS SCALE/MI
C-FACTOR
LEGEND
SCRAPER RUNS, NO
SCALE LBS/MI
N_2 NO_2 %W
C-FACTOR
1952 JAN FEB MAR APR MAY JUNE JUL AUG SEPT OCT NOV DEC 1953 JAN FEB MAR APR MAY JUNE JUL AUG SEPT

Fig. 2—Quick inhibitor buildup kept this 14-in. line in good condition.

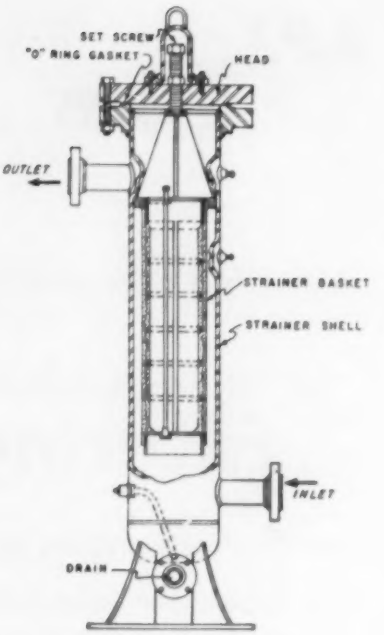


Fig. 5—Vertical basket-type filter.

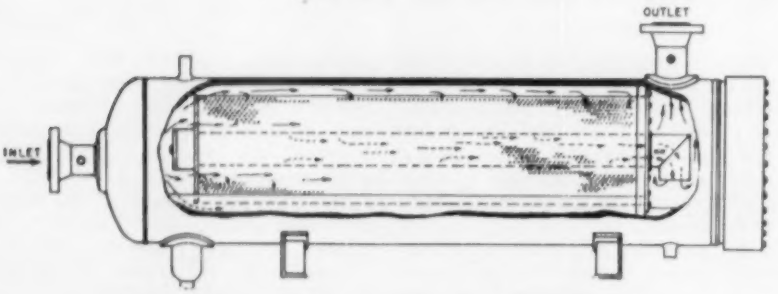


Fig. 3—Cutaway of 36-in. hay-filter shell with filter assembly.

remove all material larger than the meter clearance. Large quantities of fine sediment can be very detrimental to mechanical seals on pumps.

Types of Strainers

A survey of the industry shows that the following strainers and filters are in use:

Y-type strainers are employed for pump protection against large particles.

Settling tanks and scale traps are used for catching scraper heads and for trapping solids in front of pump stations so that dirt and water can be settled out.

Hay tanks are used quite widely and are very effective scale traps. Fig. 3 shows their general construction.

Water separators with automatic water draws find fairly wide usage. Fig. 4 shows the general makeup of these units. The excelsior in the front coalesces the water, and the settling chamber in back facilitates its removal.

Basket-type strainers similar to that shown in Fig. 5 are also widely used. Flow is from the outside to the center. The particle size of solids removed by this filter depends upon the filter medium wrapped around the basket. Some of those used are 40, 60, 100, and 200-mesh screen, ¼-in. felts, linen cloth, and an unwoven rayon fabric. A 30-mesh screen supports the paper, and a coarser screen serves as a mechanical wrap to protect the paper as this particular basket is lowered past the flange on the inside of the strainer. It is inexpensive, and experience of at least two pipelines indicates that it is as effective as the ¼-in. felt. Some basket-type strainers with screen are set horizontally and are much longer in proportion to diameter than that shown in Fig. 5.

Each of the foregoing equipment items requires manual cleaning when a certain dirt load is reached. A jet-cleaning strainer has been on the market about 2 years. This strainer can be

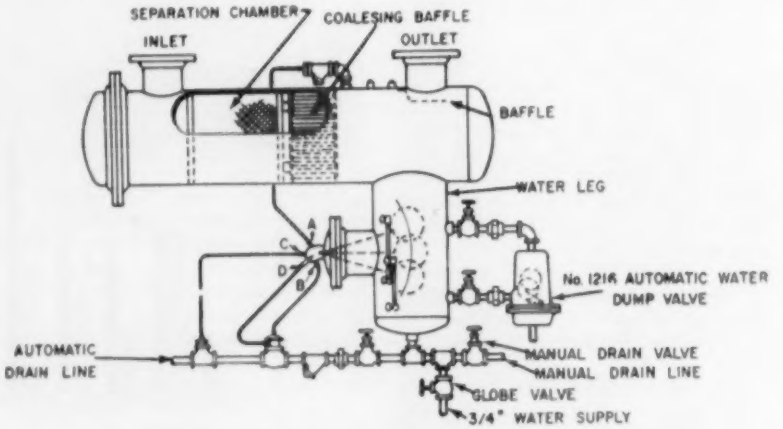


Fig. 4—Water separator with associated automatic-drain features.

Fig. 5A—Strainer basket for vertical unit.

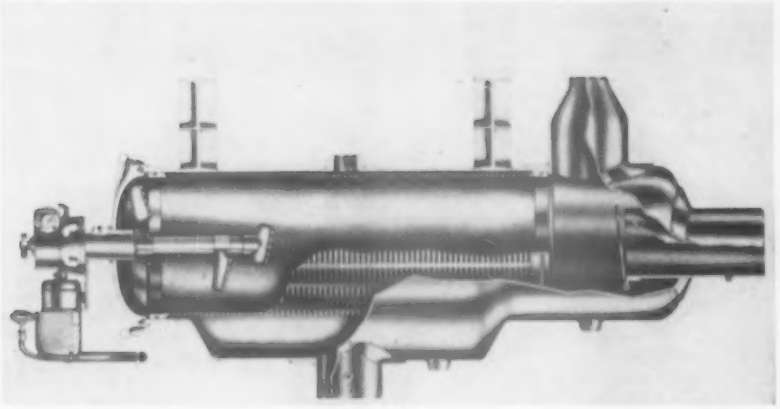


Fig. 6—Jet-cleaning strainer which can be made fully automatic in operation by utilizing the buildup of differential pressure across the screen.

drained, cleaned, and put back in operation in 3 to 5 minutes.

The strainer, Fig. 6, filters from the inside out. As the screen stops up, the pressure differential across the screen goes up to a predetermined point where an alarm signals the operator. He adds a spare strainer, drains the dirty strainer, sets up his cleaning-fluid flow, pushes a button which starts three operations — the jet arm, the cleaning pump to give 200-lb. jet pressure, and a timer which controls the cleaning period. The cleaning spray is applied to the dirty side of the screen.

Fig. 7 shows a dirty 100-mesh screen, and Fig. 8 shows this screen after cleaning. In 3 to 5 minutes the strainer is ready to go back into operation.

A new pipeline has installed these strainers with controls to make them completely automatic. The cleaning is very efficient and appears to be thorough. The original set of five strainers has been in operation on our lines for 2 years without clogging of screens. Four-hundred-mesh twilled Dutch-weave screen on these strainers gives as good or better cleaning than any other type of pipeline strainer. Some tests run by us have shown that a 200-mesh screen is equivalent to a ¼-in. thick felt.

A few miscellaneous strainers with special backwash features have been installed on pipelines. Some of these are disk type and others are screen. One of these is referred to as "multitube" in this report. An increase of area without increase in volume is achieved by in-

Fig. 7—One-hundred-mesh screen used in jet cleaning strainer. Cleaning with jet takes about 5 minutes.

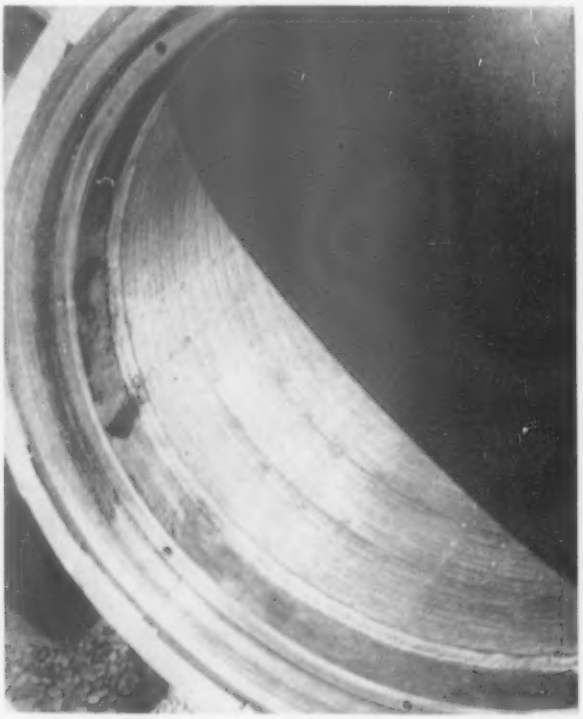


Fig. 8—Same screen after cleaning. Jet is applied to dirty side and accumulation is washed into sump.

APPENDIX I—PHYSICAL DESCRIPTION

Code	Pipe (miles)	Diameter (in.)	Age (years)	Pump stations	Terminals	Bbl./day
22	5,146	4,6,8,12	24	51	15	220,000
20	822	6,8	24	16	23	86,000
19	80	6	24	2	3	17,000
2	860	4,6,8,12	23	15	49	100,000
23c	129	3,4,6	15-23	2	5	14,400
10	2,119	8,10,12	23 and 15	29	10	109,000
20a	114	8	18	4	2	38,000
21	352	8	16	10	5	33,000
21a	176	6,8	16 and 8	1	3	25,000
1	483	6,8	15	14	9	38,000
17	450	6,8	14	6	4	21,000
23	273	4,6	14	3	9	8,200
12	813	10,12	13	14	13	58,500
17a	150	8	13	1	1	16,000
21b	82	6	12	1	2	7,400
13	150	10	11	4	2	37,000
13b	313	8,10,12	11	6	2	22,000
23a	521	4,6,8,10,12	8	5	14	27,000
5	275	8	8	3	4	22,000
18	349	8,6	8	8	5	28,000
3	178	12	7	1	5	35,000
4b	85	8	7	3	1	33,000
8	268	8	7	5	2	24,500
9	286	3,4,6,8,10	7	8	1	37,000
17c	467	8,10	7	5	3	28,000
10a	355	6	7	7	2	15,000
17b	207	10,12	7	2	2	15,000
23b	124	6	6	1	3	7,300
14	264	10	6	2	3	32,000
20b	130	8	4	3	1	18,000
25	284	8,10,12	4	3	6	30,000
12a	789	14,18	3	13	13	166,500
16	1,035	8	2-5	6	9	40,000
21c	279	14	2	6	3	51,000
19a	98	6	2	1	2	5,000
11	442	10	2	6	10	37,000
17d	140	8,10	2	1	1	11,000
24	291	8	22 months	1	1	13,500
6	258	10	1	1	1	18,000
17g	242	10,12	1	2	3	34,000
15	46	8	1	1	0	25,000
17f	200	10	1	1	1	5,000
15a	250	8,10	1	5	1	25,000
17e	309	12	1	1		27,000
18a	368	16,14,10,8	1	5	8	70,000
20c	61	6,8	1	2	3	20,000
20d	210	8	1	2	4	20,000
21d	294	16	11 months	2	8	26,000
4a	97	10	1/3	2	0	43,000
4	368	12	1/6	2	3	35,000
13a	373	6,8,10	1/6	2	1	6,500
24a	533	10	1 month	1	4	18,000
7	263	8,10,12	0	3	4	64,000

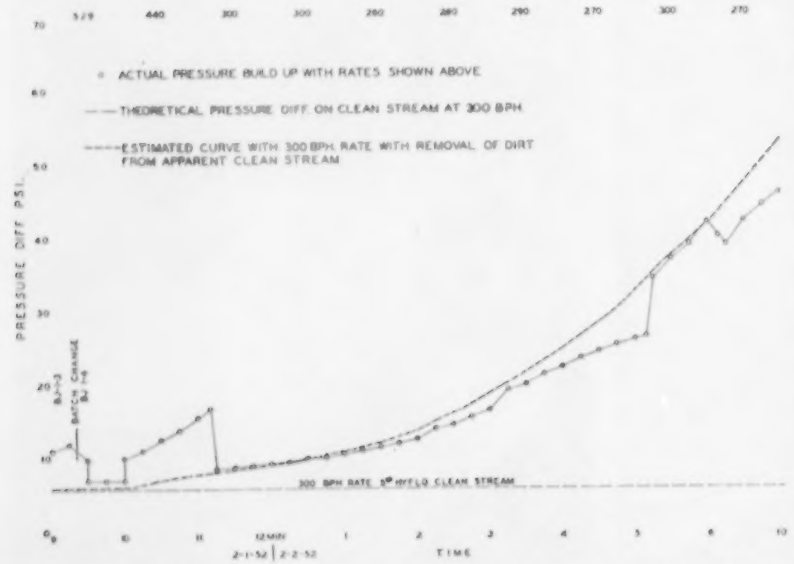


Fig. 9—Pressure buildup across strainer using diatomaceous earth. Extremely small rouge particles are removable with this device.

stalling a group of 2-in. tubes covered with 200-mesh screen. It is arranged so that one tube at a time is backwashed.

One difficulty with the backwash type is that the back pressure is always less than the incoming pressure, and cleaning would appear to be spotty and to use large amounts of fluid.

Results of Survey

A questionnaire was sent to 31 operating companies. The answers are tabulated in Appendixes I through III. All items in the appendixes are arranged in descending order of ages of various lines. Each company has been given a number and, whenever more than one line is reported, a letter has been added. For example, 4, 4a, and 4b are operated by the same company.

Appendix I, "Physical Description," shows length and size of line, number of pump stations and terminals, and daily throughput.

Appendix II, "Products and Corrosion Control," shows products handled, product source, storage data, and corrosion control methods.

Appendix III, "Filtration and Metering," shows filtering practices at input stations, pumping stations, and terminals; and associated metering practices.

Results . . . As shown in Appendix I, 25 operators reported on 53 pipelines with 23,251 miles of pipe ranging in diameter from 3 in. through 18 in., 301 pump stations, 289 terminals. The lines range in age from 24 years down to 1 month. Practically all lines handle motor gasoline, kerosine, diesel fuel, and/or heating oils. Fifteen handle aviation gasoline, and nine handle other products than those listed, among which are liquefied petroleum products, crude oil, natural gasoline, jet fuel, etc.

Most products are collected in input storage tanks; however, some come directly from refinery storage, and some pass directly from one pipeline to another. A number of pipelines continue transportation started by barge and tanker. To alleviate dirt and water many storage tanks are operated with swing lines. However, more than 50 per cent take suction from bottom or near bottom of tanks (see Appendix II).

Control of internal corrosion and scraper programs are important factors in pipeline operation as shown in Appendix II. Whenever oil-soluble inhibitors are used, the material is injected at refinery or by chemical feeders at the input station. Water-soluble inhibitors are generally injected continuously at each pumping station. Operators of lines using inhibitor for more than 1 year report very good or excellent re-

APPENDIX II—PRODUCTS AND CORROSION CONTROL

Code	Products[1] pumped	Product[2] source	Pipeline operates input storage	Tank suction	Inhibitor	Dehydrate	Scrapers No./Mo.
22	G,D	R	No	18 in.	Water soluble	No	3/yr.
20	G,K,D	R,P	No	Near bottom	Oil soluble	No	4/yr.
19	G,K,D	R	No	Near bottom	Water soluble	No	4
2	G,K,D	R,B,T,P	No	Swing	Oil soluble	No	1
23c	G*,K,D	R,B,T	No	Bottom (gaso.)	None	Yes	None
10	G*,K,D+	R,B,P	No	Near bottom	None	Yes	None
20a	G,K,D+	R	No	Near bottom	Oil soluble	No	4/yr.
21	G*,K,D+	R	No	Swing	Water soluble	No	...
21a	G*,K,D	R,P	No	Near bottom	Water soluble	No	...
1	G,K,D	B,T	No	10 in.	Water soluble	No	1
17	G,K,D	R	No	Near bottom	Water soluble	No	1
23	G*,K,D	R	No	Bottom	None	Yes	None
12	K,D	R,B,P	Yes	Sump	Water soluble	No	1
17a	G,K,D	R	No	Near bottom	Water soluble	No	1
21b	G,K,D	B,T	No	Swing	Water soluble	No	...
13	G,K,D	P	Yes	Swing	None	No	4
13b	G,K,D	R	Yes	Swing	Water soluble	No	4
23a	G*,K,D	R,B,T	No	Bottom	Oil soluble	Partial	None
5	G*	R	Yes	Bottom	Oil soluble	No	4/yr.
18	G,K,D+	R	No	...	Water soluble	No	1
3	G*,K,D	R	Yes	17 in.	Oil soluble	No	1½
4b	G,D	R,P	Yes	Fixed trough	Water soluble	No	None
8	G,K,D	R	No	Bottom	None	Yes	1
9	G,K,D	R	Yes	Ell up from bott.	Oil soluble	No	4
17c	G,K,D	P	Yes	Near bottom	None	Yes	1
10a	G*,K,D+	R	No	Near bottom	None	Yes	None
17b	G,K,D	R	No	Near bottom	None	Yes	1
23b	G*,K,D	B,T	No	Bottom	None	Yes	None
14	G,K,D	R	No	Swing	Oil soluble	No	2
20b	D+	R,P	No	Near bottom	None	No	4/yr.
25	G,K,D	P	No	...	Oil soluble	No	...
12a	G,K	R,B,P	Yes	Sump	Water soluble	No	4
16	G,K,D+	R,P	No	Bottom	Oil soluble	No	4/yr.
21c	G*,K,D+	R	No	Swing	Water soluble	No	...
19a	G,K	R	No	Near bottom	Water soluble	No	8
11	G*,K,D	R	No	Near bottom	Water soluble	No	...
17d	G,K,D	R	No	Near bottom	None	Yes	6/yr.
24	G,D	R	Yes	Near bottom	Oil soluble	Yes	4
6	G,K,D	R,B,T,P	No	18 in.	Oil soluble	No	3
17g	G*,K,D	R	No	Near bottom	None	Yes	1
15	G,K,D+	R	No	Bottom	Oil soluble	No	2
17f	G,K,D	P	Yes	Near bottom	None	Yes	None
15a	G,K,D+	R,P	No	Bottom	Oil soluble	No	2
17e	G,K,D	R	No	Near bottom	None	Yes	1
18a	G,K,D	R,B,T,P	Yes	Bottom	Oil soluble	No	2
20c	G,K,D+	R,P	No	Near bottom	Oil soluble	No	4/yr.
20d	G,K,D	R	No	Near bottom	Oil soluble	No	None
21d	G*,K,D	R,P	No	Near bottom	Water soluble	No	4
4a	G,D	R	No	Fixed trough	Water soluble	No	...
4	G,D	R,P	Yes	Fixed trough	Water soluble	No	...
13a	G,K,D	R	Yes	Swing	None	No	1
24a	G,D	R	No	Near bottom	Oil soluble	No	...
7	G*,D	R,B,P	No	Swing	Oil soluble	No	...

1. Symbols: G*—Aviation gasoline in addition to motor; K—Kerosine; D—Diesel fuel and/or heating oils. +—Other products. 2. Symbols: R—Refinery; B—Barge; T—Tankers; P—Pipeline.

APPENDIX III—FILTRATION AND METERING

Code	Input stations: Meters	Input stations: Filters	Pump station filters	Terminals: Meters	Terminals: Filters	Meter life, thous. of bbl.
22	No	Basket 7 mesh (m.)	Hay tank	No	None	...
20	Yes	Set. tank, basket 90 m.	Set. tank, basket	Yes	Set. tank, basket 90 m., exp. jet cleaning	2,000
19	Yes	Hay tank, water sep.	Y-type	No	...	1,500
2	No	Basket 40 m.	Basket	Yes	Basket 40 m., set. trap—scraper head	1,000
23c	Yes	Basket 40 m.	Basket	Yes	Basket 40 m.	350
10	No	Water sep.	None	No	None	...
20a	Yes	Set. tank, basket 90 m.	Set. tank, basket	Yes	Set. tank, basket 90 m.	1,500
21	Yes	Basket 60 m.	...	Yes	Basket 60 m.	1,000
21a	Yes	Hay tank	...	Yes	Basket 60 m.	1,000
1	Yes	Water sep., basket ¼-in. felt	Hay tank	Yes	Hay tank	1,000

sults. Table 1 summarizes the corrosion-control methods employed.

TABLE 1—SUMMARY OF CORROSION-CONTROL METHODS

Pipelines (per cent)	Corrosion-control method
25	Dehydrate products
36	Use water-soluble inhibitors
36	Use oil-soluble inhibitors
3	None

Sixty-five per cent of lines have regular scraper programs to swab pipe and to remove any corrosion products which may have deposited. Scraper heads are set aside for dirt and water to settle in 43 per cent of the lines. The remainder handle them as regular stream.

Table 2 shows how products are handled into line and into terminal storage.

TABLE 2—PROCEDURE FOR HANDLING STORAGE

	Per cent
Input Storage	
Operated by pipeline	26
Meters to line	64
Operated by other	74
Meters to line	77
Terminal Storage	
Operated by pipeline	18
Meters to storage	33
Operated by shipper	82
Meters to storage	93

Pipeline operators of terminal storage generally filter and meter products at loading racks.

Pipeline-meter life runs from 150,000 to 3,000,000 bbl. There is no correlation between meter life and filtering practices or control of internal corrosion. This is believed to be caused in part by type of maintenance program, frequency of start-and-stop operation, and the like. It is apparent that those operators using meters are getting excellent service.

A complete summary of filtering and metering practices is shown in Appendix III, and a summary of types of filters is shown in Table 3.

This survey shows a great interest in

TABLE 3—TYPES OF FILTERS

	No. of lines using: Input	Pumping	Terminals
Y-type strainers	...	6	...
Scale traps	2	3	2
Settling tanks	9	8	17
Hay tanks	7	10	4
Water separators	15	...	1
Basket	...	18	...
¼-in. felt	2	...	2
7-mesh screen	1	...	...
20-mesh screen	2	...	...
40-mesh screen	12	...	6
60-mesh screen	9	...	12
80-90-mesh screen	6	...	6
100-200-mesh screen	3	...	3
Unwoven fabric	3	...	1
Jet cleaning:			
200-mesh screen	3	1	3
400-mesh screen	...	...	1
Multitude:			
200-mesh screen	2	1	1
King	...	...	1

APPENDIX III—FILTRATION AND METERING (Continued)

Code	Input stations		Pump station filters	Terminals		Meter life, thous. of bbl.
	Meters	Filters		Meters	Filters	
17	Yes	Basket 20 m.	Y-type	Yes	Set. tank, basket 60 m.	500
23	Yes	Basket 40 m.	Basket	Yes	Basket 40 m.	350
12	Yes	Hay tank, basket unwoven fabric	Hay tank	Yes	Basket ¼-in. felt	3,000
17a	Yes	Basket 20 m.	.....	Yes	Set. tank, basket 60 m.	500
21b	Yes	Basket 60 m.	.....	Yes	Basket 60 m.	1,000
13	No	Scale trap	Scale trap	No	.....	.....
13b	No	Scale trap	Scale trap	No	.....	.....
23a	Yes	Water sep., basket 40 m.	Basket	Yes	Basket 40 m.	350
5	Yes	Basket unwoven fabric	Hay tank, basket	Yes	Set. tank, scraper head, hay tank, basket unwoven fabric	3,000
18	No	Set. tank	Set. tank	Yes	Set. tank	300
3	Yes	Water sep., basket 100 m.	.....	Yes	Set. tank, basket 100 m.	3,000
4b	No	Hay tank	Y-type	No	None	.....
8	Yes	Water sep., basket 40 m.	Basket	Yes	Set. tank, scraper head, basket 40 m.	150
9	No	Set. tank	Set. tank, Y-type	No	Set. tank	.....
17c	Yes	Set. tank, basket 60 m.	Y-type	Yes	Set. tank, basket 60 m.	500
10a	Yes	Water sep., basket 100 m.	None	Yes	Basket	1,000
17b	Yes	Water sep., basket 40 m.	Basket	Yes	Set. tank, basket 60 m.	500
23b	Yes	Water sep., basket 40 m.	Basket	Yes	Basket 40 m.	350
14	Yes	Basket 100 m.	Basket	Yes	Basket 100 to 200 m.	1,000
20b	Yes	Set. tank, basket 90 m.	Set. tank, basket	Yes	Set. tank, basket 90 m.	4,000
25	No	Basket 40 m.	Set. tank	No	None	.....
12a	Yes	Water sep., basket unwoven fabric	Hay tank	Yes	Basket ¼-in. felt, jet cleaning 400 m. at 2 term.	1,000
16	No	Hay tank, basket 60 m.	Basket	Yes	Hay tank at end, basket 60 or 120 m.	.....
21c	Yes	Basket 60 m.	.....	Yes	Basket 60 m.	6,000
19a	Yes	Hay tank, basket ¼-in. felt	.....	Yes	.....	800
11	Yes	Water sep., basket 60 m.	Basket	Yes	None	*5,000
17d	Yes	Water sep., basket 40 m.	Y-type	Yes	Set. tank, basket 60 m.	*500
24	Yes	Basket 80 m.	.....	Yes	Basket 80 m.	(‡)
6	Yes	Basket 60 m.	Basket	(†)	Scale trap	.....
17g	Yes	Water sep., basket 40 m.	Basket	Yes	Set. tank, basket 60 m.	*500
15	.....	Hay tank	Hay tank	.....	Delivers to a pipeline	.....
17f	Yes	Set. tank, basket 60 m.	.....	Yes	.....	*500
15a	No	Hay tank	Hay tank	Yes	Hay tank	(‡)
17e	Yes	Water sep., basket 40 m.	.....	Yes	Set. tank, basket 60 m.	*500
18a	Yes	Water sep., basket 40 m.	Hay tank	Yes	Hay tank, basket 40 m.	*1,000
20c	Yes	Set. tank, basket 90 m.	Set. tank, basket	Yes	Set. tank, basket 90 m.	*3,000
20d	Yes	Set. tank, basket 90 m.	Set. tank, basket	Yes	Set. tank, basket 90 m.	*3,000
21d	Yes	Basket 60 m.	Hay tank	Yes	Basket 60 m.	6,000
4a	.....	Jet cleaning 200 m; 1 set multitube 200 m.	.....	.....	Delivers to a pipeline	.....
4	Some	Jet cleaning 200 m.	Jet cleaning 200 m.	Some	Jet cleaning 200 m. King strainer at 1 term.	(‡)
13a	No	Scale trap	Scale trap	No	.....	.....
24a	Yes	Jet cleaning 200 m.	.....	Yes	Jet cleaning 200 m.	(‡)
7	Yes	Water sep., multitube 200 m.	Hay tank, multitube	Yes	Water sep., multitube 200 m.	(‡)

*Experience limited. †Converted crude line and will meter as soon as cleans up. ‡No data due to newness of system.

Set. = Settling tank. Sep. = Separator.

filtration and metering. It appears that relatively clean products put into a system with good corrosion control can meet present-day shipper demands and meter requirements if moderately fine filters are maintained in good order.

Looking to the future, it will pay each operator to consider methods for improvement both in design of equipment and disposing of dirt removed by filters. For example, we believe that the jet-cleaning strainer with 400-mesh screen does a better filtering job and requires less time for maintenance and cleaning than any other one on the market. But we do not know how to get the fines removed by the strainer out of the system. They are too fine to settle in an ordinary water products separator.

Research is being carried out on the use of diatomaceous-earth-coated screens. This material will collect rouge from a stream which appears clean to the eye. This is a surface effect and, therefore, blinds fairly quickly. Fig. 9 shows the rate of pressure buildup with time. Another approach may be to develop a procedure to coagulate the fine rouge and emulsion into large particles which will be easier to filter out and to remove from the system.

There is some evidence that the present trend of putting additives in gasolines and fuels increases emulsification and dirt-holding power. In these cases the water and dirt may not settle as well as desired in storage and thereby may require more filtration to achieve present results.

In a nutshell . . .

A survey of products-pipeline filtering practices shows that filtering is necessary to protect pumping and metering equipment against damage and wear, and to control sediment in products. Finer filtration than is the general practice is necessary for adequate protection of meters and mechanical pump seals.

Corrosion control should be practiced to minimize quantity of sediment to be removed. This control is effected through inhibitor programs using either water or oil-soluble inhibitors, or by dehydration of the product.

Offshore oil comes high, says one of the pioneers, who tells

What It Costs to Do Business in the Ocean

by Dean A. McGee

OVER 8 years have now elapsed since an offshore well was commenced in May 1946 approximately 10 miles in the ocean, off the Louisiana coast, to initiate postwar exploration of the Continental Shelf in the Gulf of Mexico. On July 1, 1954, exploratory wells had been drilled on 60 structures and a total of 501 wells had been drilled in the tidelands, including the Louisiana Breton Sound area.

The daily offshore production of oil and condensate was 47,000 bbls. from 264 producing wells. Gas production was 138,000,000 cu. ft. per day from 26 wells. Forty-four gas wells were shut in. There were 19 oil fields and 14 gas fields for a total of 33 offshore fields. A total of 177 dry holes had been drilled, 168 off Louisiana and 9 off Texas.

Author is president, Kerr-McGee Oil Industries, Inc., Oklahoma City. Paper presented at annual meeting, A.P.I., Chicago, November 10, 1954.

While it is true that the availability of low-cost war-surplus equipment and the partial shutdown of operations for several years, occasioned by the Supreme Court decision in the Louisiana and Texas cases, have affected costs to some extent, and that introduction of new and improved devices and methods may further affect cost data, nevertheless, sufficient time has elapsed and an adequate number of wells have been drilled and produced to give a fairly good idea of what it is costing to do business in the ocean.

Shelf area . . . A brief look at the Continental Shelf off the Louisiana and Texas coasts explains why the oil industry is so vitally interested. The shelf, an extension of the flat coastal plain, slopes very gradually from an elevation of about 600 ft. above sea level at some interior points to about 600 ft. below sea level. At this depth the bottom of the gulf drops away rapidly to the ocean deeps. In the Gulf of Mexico the shelf extends out 70 miles off the mouth of the Rio Grande and 140 miles off the mouth of the Sabine River.

Since the discovery of oil at Spindletop in 1901, more than 556 producing structures have been found on the land portion of this shelf in an area of approximately 39,000 sq. miles extending westward from the Mississippi River to the Rio Grande and extending inland from the coast from 20 to 90 miles. An equivalent area in the gulf would extend from the shore line out to a water depth of about 160 ft. It would have a maximum width of 98 miles off the Sabine River.

The development of these 556 structures has required the drilling of about 36,000 development wells and resulted in the discovery of something over 11 billion barrels of oil and 67 trillion cubic feet of gas. Approximately 37,000 dry holes have been drilled. Of these 556 oil fields, 16 will have in excess of 100 million barrels recovery, 29 will have recoveries between 50 and 100 million barrels, and 53 in the 25 to 50 million bracket, or a total of 98 fields that will have an ultimate recovery in excess of 25 million barrels.

The oil is being produced from three principal types of structures — salt domes, faulted structures not attributable to salt movement, and lens or stratigraphic types. All available data indicate that the same type accumulations will be found in the immediately adjacent Continental Shelf area.

While available geological information does not permit an accurate estimate of the distance offshore that favorable stratigraphic and structural conditions exist, offshore well data indicate that nearly all formational units are continuing to thicken seaward. Geophysical exploration has disclosed favorable structural conditions far at sea. Certainly, exploration to date has shown the offshore area to be comparable, in number and quality of salt-dome structures, with the coastal belt.

Offshore Operations

While the gravity meter, airborne magnetometer, core drill, and refraction seismograph have been used to some extent, substantially all offshore exploration has been and is being done with the reflection seismograph. Water seismic techniques and equipment are very efficient and now include tow cables, radio surveying, packaged explosives, and the use of large boats.

The cost of a water crew may vary from $60,000 to $100,000 a month

These charts show why offshore operations don't appeal to small budgets

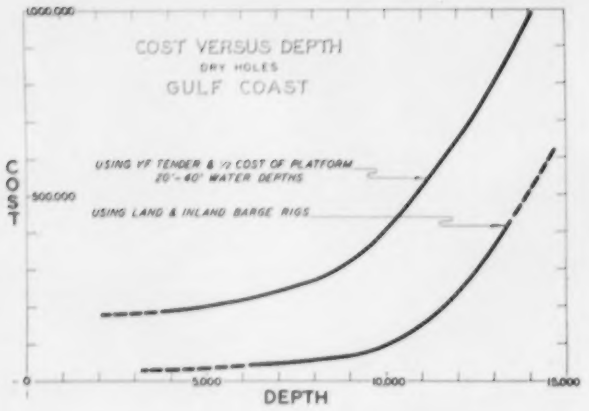


Fig. 1

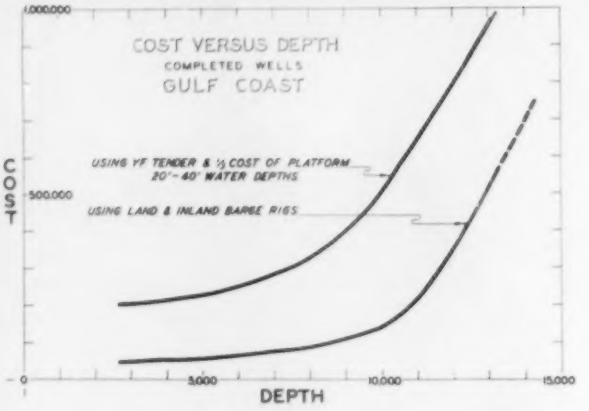


Fig. 2

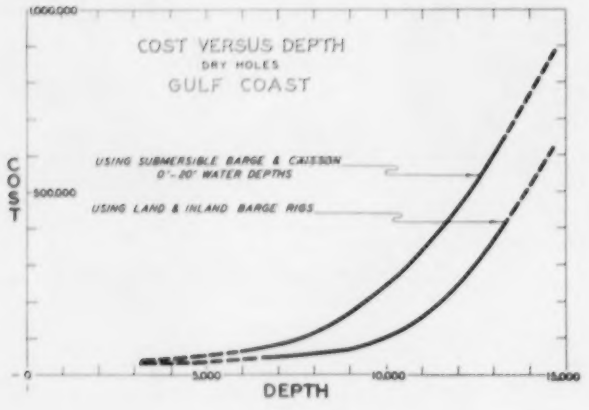


Fig. 3

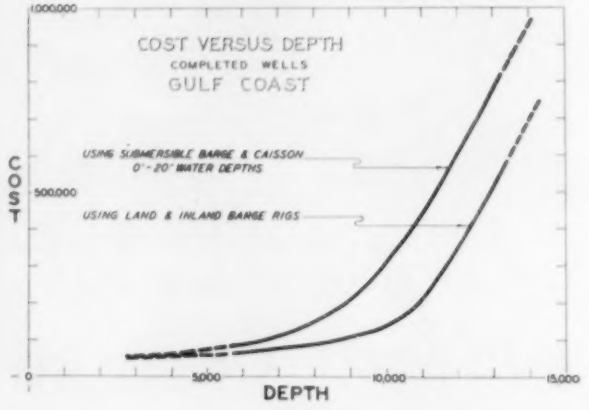


Fig. 4

depending on the type of operation. An average land crew in coastal Louisiana and Texas costs from $15,000 to $25,000 per month. Because of the much greater production per month of water-borne crews, the cost per profile obtained is presently in the $20 to $40 range as compared to a $30 to $50 profile cost on the coastal land belt or approximately 75 per cent of land cost.

In comparing land and water exploration costs, it should be remembered that the search for oil and gas has continued on the coastal land belt over a period of more than 50 years—starting with methods of very low finding power and progressing through the use of the torsion balance, micropaleonotology, and the refraction seismograph to the reflection seismic method which became available about 1930 and ushered in the period of greatest discovery in the coastal areas.

As instruments, techniques, and skill in interpretation have improved through the years since 1930, the finding power of the reflection seismic method has increased many fold. Many coastal land areas have been surveyed again and again with the seismograph following each such significant improvement. Consequently, time has very definitely been a function of cost, starting with the low-finding-power methods of more than 50 years ago.

Operators in the tidelands have available to them all the tools and techniques, as well as the experience accumulated in this half century, to apply to the search for the same type structural and stratigraphic accumulations. In addition, at this time only the large, prominent salt-dome structures are of interest. As a result, the finding rate has been exceptionally high and the cost per first-class structure found is low.

Lease costs . . . Lease bonus costs have mounted steadily since the first lease sale, following the war in August 1945. At this sale the State of Louisiana sold about 89,000 acres for an average of $5.13 per acre. On December 1, 1953, the State of Texas held its first lease sale following the signing of the federal Tidelands Act. At this sale about 400,000 acres were sold for an average of $78.50 per acre. One lease sold for $532 per acre. Louisiana held a lease sale on September 14 of this year at which one tract was sold for $5,265,000, or $1,053 per acre.

These large increases in bonuses paid reflect the fact that when lease sales were resumed after the enactment of the federal tidelands law more companies had become interested in offshore operations. Those companies that had elected to stay out of the tidelands in the early years had an opportunity during the 3 years of partial shutdown to catch up on seismic exploration. Operators who had mapped prospects, but who were foreclosed during the tidelands controversy from leasing them, found that the number of their competitors had increased materially when leases were first offered again in December 1953.

Altogether the two states have sold through September 14, 1954, approximately 1,850,000 acres of leases for about $78,000,000 in bonuses. In addition Louisiana has collected each

TABLE 1—COMPARISON OF INVESTMENTS REQUIRED FOR OFFSHORE EQUIPMENT

Type Operation	Drilling equipment	Drilling tender (1)	Crew-boats (3)	Location or platform exp.	LCT (1)	Tug (1)	Total Investment (1954)
YF tender and minimum platform (35 ft. water)	*$250,000	$ 700,000	$1,110,000	$240,000 (80,000 ea.)	$125,000	$250,000 (700 hp.)	$2,665,000
Deep water submersible barge rig (20 ft. water)	†15,000	1,500,000 (barge & rig)		240,000	125,000	250,000	2,130,000
Deep water submersible barge rig (35 ft. water)	†50,000	2,000,000 (barge & rig)		240,000	125,000	250,000	2,665,000
Self contained platform (60 ft. water)	‡800,000	700,000		240,000	125,000	§250,000	2,115,000
Portable platform or similar device (100 ft. water)		2,000,000 to 3,500,000		240,000	125,000	§250,000	2,615,000 to 4,115,000

*Approximately 45 per cent salvageable or $112,500. †All salvageable in case of dry hole. ‡Approximately 45 per cent salvageable or $360,000. §Could be rented for water haul.

year one-half of the bonus price for all leases kept in force by payment of delay rentals which payments are a sizable total.

These figures are large and the totals will increase rapidly with each lease sale. However, on the coastal land belt over the past 50 years a number of tracts have been leased time and again at substantial bonuses. Rentals have been paid on some tracts over most of the 50-year period. In addition operators have kept under lease, large amounts of checkerboard and protection acreage located on structural anomalies of doubtful value.

Large sums have been spent on curing titles, title law suits, pooling of small tracts, offset royalty, and drainage and damage claims, to mention only a few that will not be duplicated in the tidelands. The total of all these accumulated costs over more than 50 years would be an interesting figure to compare to the total that will finally be paid for selected offshore acreage.

Drilling Methods

For the drilling of wells in the gulf tidelands, either exploratory or development, three general methods have been and are being used. These are the self-contained platform, the small platform-floating drilling tender, and the mobile device. The self-contained platforms and the floating tender-small platform arrangements were used to drill the early wells, starting in 1946 and 1947. The floating tender-small platform method proved early to be more economical and more flexible in its use than the self-contained platform. Consequently about 90 per cent of all the wells drilled to date have used this method.

A mobile device of the submergible-barge type was first used in open gulf waters in June 1952. Until April of this year, there were no other mobile units in such use. Within the past few months several additional mobile units have been put into service and several more are under construction. The submergible-barge type mobile unit is at present limited to water depths up to 40 ft.

Several devices are being built for use in water up to 100 ft. in depth and still others are proposed. Since detailed information is readily available from many sources on all of these drilling methods and equipment, no attempt will be made to describe their design and use.

Operations base . . . To operate any of the above devices off shore, a base of operations must be provided. A permanent base should be in protected waters, should be on a navigable channel to the gulf, and should provide as facilities an office, a warehouse, communications center, some living accommodations, pipe racks and equipment and supply yard space, oil-storage tanks, and a slip. For the drilling of wildcat wells temporary dockage can be used and temporary communication and supply operations provided.

A complete offshore drilling unit requires three crew or personnel boats in the 65-85-ft. class to transport up to 30 passengers and small supplies from the base to the rig. One boat is kept standing by the rig at all times for the evacuation of personnel in an emergency. Another is usually in transit and the third boat is kept in reserve at the base in case of a breakdown and for special unscheduled trips.

In the early operations most of these boats were secured from U. S. Army and Navy surplus marine equipment. These surplus boats were largely of wood construction. New crew boats being added in recent years are of steel construction and especially designed for the purpose.

Boats needed . . . A work boat is required. The boat that has proved most successful for this purpose is the war-surplus LCT. These vessels are self-propelled and capable of carrying about a thousand barrels of water, heavy equipment of all types, chemicals, cement, mud, and tubular goods. Since war-surplus LCTs are no longer available, new boats of this same general design have been and are being built. It is anticipated that many more boats of similar design will be needed.

In addition to the three crew personnel boats and the work boat, tug boats of about 700-hp. capacity are needed at certain times of the year, especially during the hurricane season and for short periods when equipment is being moved. Occasionally a deck-cargo barge is used in connection with the tug for carrying supplies and water.

As an auxiliary to the drilling operation a dependable means of communication between rig and shore is necessary. Each operation must set up its own FM radio and marine telephone facilities. Some operators equip their personnel and work boats and platforms with radar.

Capital Investment

Table 1 shows average 1954 equipment investment figures for five different types of offshore operation. In each case to the total figure in the last column should be added the investment in marine base and facilities, which is usually about $200,000.

The rigs and other drilling equipment used for offshore drilling are oversized and designed to meet maximum anticipated requirements. They generally range in capacity from 1,200 to 2,000 hp.

Since war-surplus equipment is no longer available and much of this type of equipment has been in operation for 7 to 8 years and can be expected to become inoperable at a fairly early date, an operator assembling marine equipment for a complete offshore unit will be required to make approximately the investment shown in Table 1.

While the industry has been anticipating lower drilling costs in the ocean from improvements in methods and

techniques, actually costs have been rising. New devices are costing more to build than those that have been in use. Higher capital investment in offshore equipment and facilities can only mean higher daily operating costs.

It should be pointed out that currently much of the thinking is being directed toward the design of devices that will permit drilling in deeper water up to 100 ft. in depth. Only a few years ago drilling in 60 ft. of water was a goal to be attained. As a consequence, investment costs are mounting as the accomplishment of this objective temporarily assumes more importance than its cost.

Table 2 sets out one company's 1947 investment in crew boats, work boats, tugs, tenders, and rigs. Also shown are average 1954 replacement costs and percentage increases in these costs for the 7-year period.

Effect of depth . . . In the tidelands the depth of water controls the type of equipment required for both wildcat and development drilling. None of the methods or devices currently in use is completely competitive at all water depths. The submergible barge is definitely limited to 40 ft. with existing models.

The large mobile devices being constructed for deeper water—up to 100 ft.—because of high initial cost will not be competitive at depths of less than 40 ft. The floating tender-small platform approaches being a method that is usable competitively at all water depths.

Table 3 compares the cost of drilling an 11,000-ft. dry hole in 35 ft. of water using a minimum platform and tender, a mobile platform or deep-water barge rig, and a self-contained platform. The well drilled with the mobile platform or deep-water barge rig will cost an estimated $358,000, the one drilled with the minimum platform and tender $536,000, and the one with the self-contained platform $788,000. The difference in cost is almost entirely in the cost of the platforms.

Table 4 shows the cost of an 11,000-ft. completed well in 35 ft. of water using the same drilling methods. Again all costs but those for the platforms are approximately the same.

Onshore comparisons . . . In order to compare offshore costs with onshore figures, curves have been prepared which reflect the costs incurred in the drilling of 35 offshore and 28 onshore wells. Fifteen of these offshore wells were drilled with the tender-platform arrangement and 20 were drilled with a submergible barge.

TABLE 2—INVESTMENT AND DAILY OPERATING COST OFFSHORE EQUIPMENT 1947-1954

Equipment	Average Investment 1947	Daily Cost of Operation 1947	Average Investment 1954	Daily Cost of Operation 1954	Percent Inc. in Invest.	Percent Inc. in Daily Cost
Crew boats 63 ft.	$ 18,827.50	$ 73.00	$ 80,000	$ 138.75	325	89
Crew boats 85 ft.	21,814.00	92.50	80,000	152.95	262	65.3
LCT	29,768.00	150.00	125,000	239.00	320	59.3
Tug	138,829.00	294.00	250,000	356.00	80.6	21
YF drilling tender	324,843.39	685.00	1,110,000	1,423.00	241.0	107.8
12,000-ft. rig	400,000.00	*2,000.00	650,000	*2,385.00	62.5	19.3
15,000-ft. rig	450,000.00	*2,055.00	700,000	*2,415.18	55.5	17.5

*Includes labor, supervision, supplies, insurance, repairs, fuel, depreciation, overhead, district and division expense, commissary, rental on Schlumberger and Hall equipments.

All the submergible barge wells were in water of 24 ft. or less in depth. The tender-platform wells were in water from 12 to 43 ft. in depth. The tender-platform cost figures are an average for wells drilled over a 7-year period. Costs for the submergible barge are averaged costs over the last 2 years.

Fig. 1 compares the cost of dry holes drilled offshore with the tender-platform method with similar-depth dry holes on land using land or inland barge rigs.

Fig. 2 shows the same data for completed wells.

Fig. 3 compares the cost with depth of offshore dry holes drilled with the submergible barge method with similar wells on land using land or inland barge rigs.

Fig. 4 shows the same data for completed wells.

Of course, a completely dependable set of curves cannot be constructed from limited data and in addition the costs do not include wells in water deeper than 43 ft. However, if additional platform cost for water depths up to 100 ft. is added to the well cost as shown on the curves, the resulting figure should be a reasonably close total well cost. The curves do accurately reflect average well costs for one set of data.

Barge vs. platform . . . The character of the two sets of curves for wells drilled with the tender-platform arrangement is essentially the same. The difference in cost remains fairly constant at all well depths. The curves, constructed using submergible-barge offshore costs, are roughly parallel with the curves of onshore wells at depths greater than 10,000 ft.

At depths less than 10,000 ft. the cost of wells offshore approaches the onshore cost until at 5,000 ft. the cost of both offshore dry holes and completed wells is not much greater than its counterpart on land. In general the cost curves at the shallower well depth reflects the difference in preparatory expenses.

The road, location, and rigging costs cause the onshore costs to approach that incurred with the submergible barge on offshore shallow wells. Although operating rig rates are materially higher for the submergible barge, no rigging up is necessary and in most cases only a small amount of location expense is incurred.

The high-platform and derrick-barge costs, as well as the rigging up and down time of drilling tools, cause the well costs with the platform-tender method to be considerably higher than that with the submergible barge throughout the depth range.

Just as daily amortization charges have been mounting steadily as a result of the placing in service of more

TABLE 3—COMPARISON OF TYPICAL DRY-HOLE (11,000-FT.) COSTS USING VARIOUS OFFSHORE METHODS WATER DEPTH: 35 FT.—1954 COSTS

Items of Expense	Minimum Platform and Tender	Mobile Platform or Deep Water Barge Rig	Self-Contained Platform
Platform	$250,000		$800,000
Caisson and guide piling (drilling only)		$ 25,000	
Rotary drilling (11,000-ft.)	236,805	201,005	199,305
Normal day work (10 days)	47,500 (4,750/day)	57,500 (5,750/day)	35,000 (3,500/day)
Casing (dry hole)*	62,000	62,000	62,000
Cement and cementing services	5,000	5,000	5,000
Mud and additives	22,000	22,000	22,000
Shore base and docking facilities	3,000	3,000	3,000
Rental tools, extra labor, etc.	10,000	10,000	10,000
Logging and other third party services	12,000	12,000	12,000
Total dry hole (including platform)	$648,305	$382,505	$1,148,000
Deduct platform salvage	$112,500 (45 per cent)	$ 25,000 (100 per cent)	$ 360,000 (45 per cent)
Total net dry-hole cost	$535,805	$357,505	$ 788,000

*Includes: 600 ft. 20-in. casing; 3,000 ft. 13⅜-in. casing; 9,000 ft. 9⅝-in. casing.

costly equipment and devices, operation and maintenance expenses have also been increasing sharply.

Table 2 shows one company's daily operating cost of offshore marine and drilling equipment in the year 1947. Daily operating cost increases range from a low of 17 per cent to a high of 108 per cent. These are large increases and affect materially over all well costs.

Producing methods . . . There are basically three methods now being used for operating producing offshore wells. All three schemes provide for the installation of automatic well equipment to minimize the danger of fire, blowouts, collision, and storm. Living quarters for production personnel, pumper's boats, and work boats for routine production operations must also be provided. For the handling of aboveground oil, one method provides for the mooring of an oil barge of 5,000 to 10,000-bbl. capacity at a safe distance from the production platform or in the vicinity of a piling cluster at a central point to which flow lines are laid.

Oil, after passing through separators mounted on the production platform or barge, flows directly into the barge storage. This method of operation has been considerably improved in recent years by use of pile anchorage systems. Oil is now being picked up from storage barges, by towing companies, on a contract barrelage basis. The cost varies, of course, with the location, haulage distance, and sea conditions. On one operation where the haul is 60 miles from sea storage to land terminal the contract price is 15 cents per barrel.

Experience has shown that lost time on account of the barge being off location due to weather is not excessive. One operator has used this method over a period of 3,862 storage barge operating days with time off location of slightly less than 1 per cent. This operation was in 20 ft. or less of water off the Louisiana coast. The time off location in deeper and rougher water will, of course, be greater depending on the conditions.

A second method provides for complete production facilities on offshore platforms. The facilities include tanks, separator, treaters, loading facilities, and quarters for production personnel. The usual personnel and production work boats are also a part of this method. The oil is moved from the platform storage either in shore by barge or to its ultimate destination by barge or tanker. Oil is being moved by barge from platform storage to shore terminals, rehandled, and moved to nearby refineries at costs around 25 cents per barrel. Oil can be moved by small tanker direct from field storage to coastal refineries for about 20 cents per barrel.

A third method of handling offshore oil, and certainly the most economical under favorable circumstances, provides minimum facilities on the offshore platforms from which the production as accumulated is run to shore by pipeline for treating and storage. The pipeline method has been used to date in fields close to land. It can only be employed where reserves justify the very substantial investment and where the daily volume of production is such that handling in this manner brings the producing costs sufficiently below the other two currently used methods to provide a reasonable return on the investment.

Gas and condensate . . . Production of gas and condensate offshore differs from similar operations on land in that the liquids and gas, in the fields now being produced, are moved by pipeline to shore. Liquid storage and handling facilities are not provided offshore. Separation of the condensate and gas is made in most cases by low-temperature separation equipment.

The dehydration of the gas not only permits transportation to shore without freezing of the lines but also allows the measurement of liquids and gas for allocation of production to various leases and operators before commingling. In some instances the separation and metering equipment is located on the same platform with the completed wells and in other instances the separation equipment is on a separate platform or platforms.

While the installation of separation, metering, and associated production equipment on platforms, the quartering of personnel, the providing of safeguards against fire and other hazards, and gas-gathering and transmission lines represent a very substantial investment, well costs for a gas reservoir are less than for oil because of the larger size of the producing units. Also, since liquids are not stored and transferred offshore, operating costs are favorably affected. Production costs incurred to date by one operator producing gas from two offshore fields have been in the range of $25 to $35 per million cubic feet.

The cost of producing oil and gas may be an equally, or even more, significant factor in the over-all economics of the development of offshore oil and gas fields than the cost of exploratory and development drilling. Each producing operation has its own peculiar problems. No two operations are exactly alike.

The depth of water, distance from land, prevailing weather, rate of production, size of reserves, and method of handling and transporting oil, are factors that help determine cost. At this stage of offshore operations where new fields are being and will be found in deeper and deeper water, pioneering in producting methods is required with each discovery.

In each operation the service boats, producing personnel, quartering facilities, and oil barges as well as personnel salary and subsistence represent a fixed daily cost. The daily cost is approximately the same whether the production is a few hundred barrels or several thousand barrels per day. Consequently, producing costs are far in excess of those on land until the daily production in any field reaches a volume of from 1,500 to 4,000 bbl. per day depending on the area.

Even though over-all offshore producing costs are impossible of reasonable determination, the costs being experienced on about 14 per cent of the present oil production off the Louisiana coast will be of interest. All methods were covered except the one using the pipeline for onshore movement of oil. The producing properties on which the figures were available lie in a fairly representative offshore area.

TABLE 4—COMPARISON OF COMPLETED WELL COSTS (11,000 FT.) VARIOUS OFFSHORE METHODS WATER DEPTH: 35 FT.—1954 COSTS

Items of Expense	Minimum Platform and Tender	Mobile Platform or Deep Water Barge Rig	Self-Contained Platform
From Schedule 1	*$648,305	*$382,505	*$1,148,000
Oil string casing (11,000 ft. 7-in.)	35,000	35,000	35,000
Cement and cementing services	2,500	2,500	2,500
Perforating	2,000	2,000	2,000
Tubing	17,600	17,600	17,600
Day work (completion) 10 days	47,500 (4,750/day)	57,500 (5,750/day)	35,000 (3,500/day)
Well head and christmas tree	6,000	6,000	6,000
Packers and downhole equipment	4,500	4,500	4,500
Production platform		18,000	
Miscellaneous	5,000	5,000	5,000
Total completed well cost	$768,405	$520,605	$1,255,600

*Cost of completed well includes 100 per cent charge-off on platform. †Three caisson production platform.

It should be pointed out that the data available are all from offshore fields in the early stages of production where the wells are flowing and there has been no appreciable amount of workover or large production of water. The costs on production of this type where the wells are flowing either into moored barges or into central storage batteries in volumes in the above-mentioned range, appears to be about 80 cents per barrel.

This 80 cents per barrel does not include the cost of moving the crude from the offshore location to the land destination. However, these costs are in the range of 13 to 25 cents per barrel and in some cases do not greatly exceed the charge made by field gathering systems on land.

In the more protected areas the cost appears to be as low as 50 cents per barrel. The offshore figures of 50 to 80 cents per barrel roughly compare with onshore drilling costs, including marsh and bay, of 30 to 40 cents per barrel or approximately double.

Included in the production costs are (1) direct lease lifting costs such as lease payroll, supplies, platform maintenance including cathodic protection, sandblasting and painting, paraffin cutting and other wireline service, bottom-hole-pressure tests, personnel boats, commissary, production-barge rental, field office, land base with communications; (2) severance and ad valorem taxes; and (3) district and overhead expense.

Effect of weather . . . There are several factors affecting the cost of offshore operations which are worthy of mention. Weather is an important one. While the well-publicized hurricanes are less troublesome than squalls and winter "northers," they dictate the design and construction of offshore equipment and facilities to meet maximum hurricane conditions. The loss of time during drilling operations due to tenders being off location or to inability to service the operation because of bad weather is an important consideration for most operators. The daily cost when drilling is not in progress is about 80 per cent of the cost when in full operation.

As a matter of interest, a study of the effect of weather was made on a group of wells drilled off the Louisiana and Texas coasts from 1947 through the summer of 1954. This tabulation shows that with the platform-tender method there were 2,663 days of exposure. There were 18 days lost on account of hurricanes—less than 1 per cent of the total operating days. Nonhurricane weather caused the loss of 63 days or 2.4 per cent of the total.

With the submergible-barge method there were 258 days of exposure. There was no lost time due to hurricanes. Six days were lost due to nonhurricane weather or 2.3 per cent of the total. While the wells drilled during the period of this study were located representatively in the gulf, the depth of water did not exceed 43 ft. This down time due to weather compares very favorably with lost rig time on land.

Mooring of the floating drilling tender, in the small platform-tender method of operation, so as to keep it in operating position during all kinds of weather, in close proximity to the drilling platform, has been one of the more troublesome operating problems with this method. Great improvements have been made in recent years which have resulted in a reduction of off-location time.

Another important factor is the single-purpose character of the equipment being designed and constructed for offshore use and the possibility, or even probability, in view of the present state of the art of offshore drilling, of its early obsolescence. The cost of laying up marine equipment is so high that storing it against some future use is not feasible.

Operators who build too much equipment of the types currently in use may find it necessary, because of low salvage value, to continue to drill wells with high cost methods when a more novel, lower-cost device is available. Yet in face of this, more drilling units must be provided in the near future. The number available or under construction is not sufficient to meet the steadily increasing requirements of the tidelands. On September 1 of this year there were a total of 39 units available and 5 under construction. Of the total available, 5 were mobile devices, 29 drilling tenders, and 5 were rigs on self-contained platforms.

Limiting wells . . . The cost of developing a field offshore can to some extent be controlled by limiting the number of wells completed in any one reservoir and by locating wells in the most advantageous structural position for the drainage of reservoirs. While the geology of salt-dome structures is too complex to permit planning a detailed pattern of development that will permit maximum spacing, certainly the density of drilling in offshore fields as compared to similar reservoirs on land can be decreased.

A producing unit of 30 acres or slightly less is not unusual in many of the larger onshore salt-dome fields. If a 40-acre or greater spacing of development wells can be achieved offshore, the resulting reduction in development costs will help materially to offset higher well costs.

The cost of producing oil offshore will become an increasingly important factor as additional fields are discovered and the daily production of oil grows. On the basis of some current offshore figures the total cost of producing a reservoir to depletion is a substantially larger sum than the cost of developing the field. The Department of Conservation of the State of Louisiana recognized in its first offshore conservation order that the cost of producing oil from an offshore reservoir is substantially higher than on land.

An onshore well in Louisiana 10,000 ft. deep has an allowable of 132 bbl. a 10,000-ft. well off the Louisiana coast has an allowable of 242 bbls., a 10,000-ft. well off the Texas coast on 40-acre spacing now has an allowable of 182 bbl. The maintenance of an additional allowable for a well off the Louisiana coast and the establishment of such an allowable off the coast of Texas and by the Department of the Interior for federally controlled lands, is a necessity if offshore development is to be fully encouraged.

Drilling and operating costs can and will be reduced materially as experience is accumulated by the industry. As each new band of deeper water is explored, much pioneering will have to be repeated. What is needed now in the band that has been under exploration for 7 years is not bigger and more expensive devices but less costly ones with a minimum of investment for the job.

In the tidelands, because of mineral ownership, the high finding power of present-day exploration methods, and the presence of a number of first-class salt-dome prospects, operators will be compelled to make their investment in leases and exploratory drilling in a relatively short period of time. While this may not be desirable, it should not greatly increase the ultimate cost.

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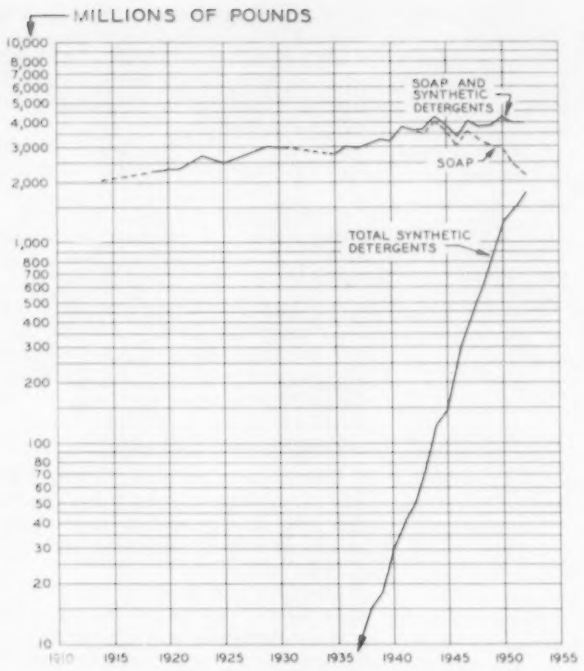

Fig. 1—Production of soap and synthetic detergents.[2]

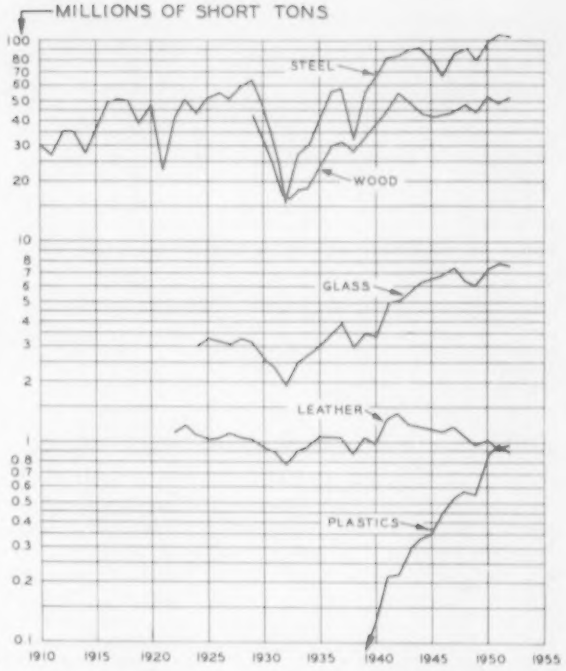

Fig. 2—Consumption of plastics vs. competitive materials.[2]

Petrochemical Expansion—It will not revolutionize oil and gas market outlook

. . . though some producers will find it profitable to supply raw materials

by T. G. Hughes

GROWTH of the petrochemical industry will have little effect on the market outlook for oil and gas production. Some individual producers—those who are able to meet the special requirements of petrochemical manufacturers—will find it advantageous to supply raw materials for this growing segment of the oil industry.

Suppliers of feed stock for petrochemical plants must meet these requirements:

- There must be an assured long-range source of supply. Large investments required for chemical plants make this mandatory.
- Raw-material prices must be competitive. The chemical industry can and will use nonpetroleum sources of raw materials if costs are lower.
- Location must be strategic. Overall transportation costs for raw materials and finished products must be kept at minimum values by the chemical manufacturer.

Author is president of Oronite Chemical Co., San Francisco. Paper presented at annual meeting, A.P.I., Chicago, November 9, 1954.

Rapid growth . . . From its beginning in the 1920's, the petrochemical industry has grown to a business with an investment of some 3 billion dollars. One hundred seventy-six companies are operating, or have planned, 322 plants in the United States and Canada. Of these 62 are petroleum companies, 102 are chemical companies, and 12 are joint ventures.[1] Investment houses, a good barometer, consider petrochemicals one of the best growth industries with good future returns promised in relation to the risk.

With this in mind, you might conclude that petrochemicals bid fair to alter the traditional markets for crude oil and gas. However, let's take a close, critical look at petrochemicals and see just what effect they should have on oil and gas production.

First of all, what makes petrochemicals so attractive to investors and, of course, in their final forms, to consumers? Taking a few of the more outstanding examples, consider first the synthetic detergents. This industry had its big start immediately following World War II when the base material now used in practically all of the synthetic detergents was developed from petroleum. The excellent cleaning ability of the products, and particularly their resistance to hard water, give them rapid acceptance by the housewives. Fig. 1 shows the history of their rise in popularity.

The first products were used primarily for washing dishes. In 1948-49

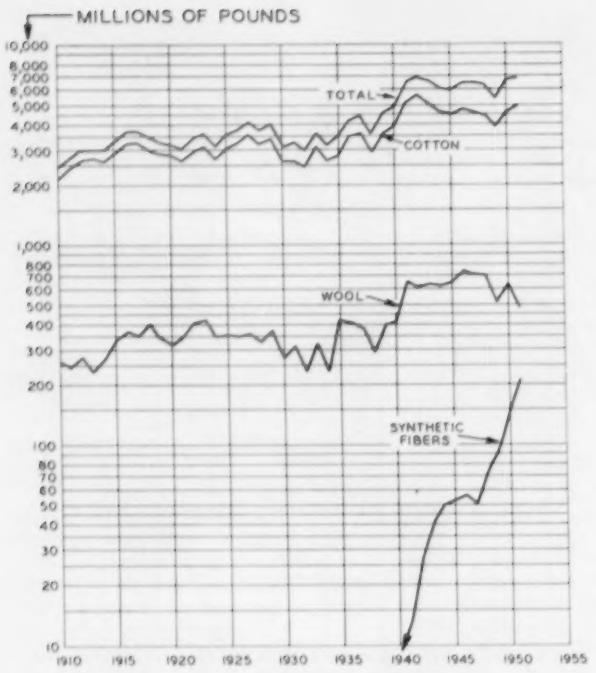

Fig. 3—Consumption of textile fibers.[3]

the soap companies developed special formulations that extended their use to the washing-machine field, so that now nearly 60 per cent of the soap-company sales are based on petroleum-derived synthetic detergents. Of course, the rate of increase is slowing down appreciably as the line approaches the total soap and detergent sales.

Plastics . . . Petrochemicals are assuming major importance in the plastic field. From Fig. 2 it will be seen that plastics have also been a rapid-growth industry. It is reasonable to expect the growth will continue in those applications where their special properties justify their higher cost. Today you can buy everything from polyethylene squeeze bottles to sports cars molded from petrochemical plastics. Although their growth has been spectacular, their consumption in pounds is still less than 1 per cent that of other structural materials, which leaves considerable room for expansion.

Dacron, polyester fiber, and most of the new synthetic fibers coming into wider use are petroleum derivatives. Their advantages, such as resistance to wrinkling, long wear, and appearance, are making them increasingly popular. Fig. 3 shows the growth of synthetic fibers against the natural fibers such as cotton and wool.

The consumption of synthetic fibers is about 200 million pounds, about 4 per cent of cotton consumption. As the percentage rises, the rate of growth will undoubtedly slacken.

Petroleum chemicals are found in almost every field of use today—synthetic rubber, gasoline and lubricating-oil additives, paint, insecticides, and medicines, to name a few. The variety of products and the untapped potential capture the imagination.

Effect on Oil and Gas

What effect is all this going to have on the business of producing oil and gas? To answer that, consider the basic characteristics that many petrochemicals have in common.

First, they derive their value and their utility, not from the intrinsic value of the raw material from which they originate, but from complex and costly manufacturing processes. Second, although we refer to these chemicals as petrochemicals, many can be manufactured just as readily from alternate raw materials, such as wood, coal, and even molasses. A classic example is du Pont nylon in which the same intermediate chemical is being produced from six different sources, as indicated in Table 1.

Because the price is favorable, oil and natural gas are pulling ahead of alternate raw materials in many lines of chemical production—nylon among them.

TABLE 1—NYLON RAW MATERIALS

Raw-material source—	Raw material
Natural gas	Butane
Gasoline fraction	Cyclohexane
Coal tar	Benzene
Oat hulls, corn cobs, sugarcane bagasse	Furfural

This following tabulation lists some other leading products and the percentages manufactured from petroleum and the alternate sources.

Chemical—	Per cent now produced from petroleum	Alternate raw material
Ammonia	85	Coal
Methyl alcohol*	80	Coal and wood
Ethyl alcohol	57	Molasses and other agricultural products
Toluene	60	Coal
Xylene	86	Coal

*Formerly called wood alcohol.

Each of these products, 30 years ago, was manufactured entirely from materials other than petroleum. So that gives an idea of how far petroleum has come in this competition.

However, advances are also being made in the technology of converting coal to chemicals. Carbide & Carbon Chemicals Co., for example, is reported to be operating an 11-million-dollar pilot plant turning 600 tons a day of coal into aromatic chemicals by coal hydrogenation.

The significance of all this to oil and gas producers should be clear. The prosperity of the petrochemical industry depends fundamentally upon big-volume, low-cost sources of raw materials.

The price has to continue to be right. If the value of crude oil or natural gas reaches the point where the alternate raw materials can come back strongly into the picture, then the petrochemical industry will begin to tail off and we'll see a booming coal-chemical industry, or a molasses-chemical industry—or a corn-cob-chemical industry — whatever happens to be cheapest. In short, very few oil and gas producers are going to wax very prosperous solely on account of the growth in petrochemicals.

However, this does not mean that some producers—those who are properly located and have sufficient long-range reserves—will not be able to profit from doing business with the petrochemical industry.

The next questions to consider, then, are: Which petrochemical markets will oil and gas producers be able to serve profitably? How big will those markets be? Here are the answers:

First, the existing crude oil marketing pattern is not going to be altered by the expansion of petrochemicals. Crude oil is composed of many thousands of different chemical compounds and many more are formed during cracking and other refining operations. Only a small number of these are desirable for the manufacture of petro-

chemicals. Thus, a fully integrated petroleum refinery is needed to separate the small percentage of desirable types for chemicals and to consume the large remainder in conventional refinery products.

Although it is true that many refineries, particularly the larger units, are entering into petrochemicals, their chemical production in oil-company units of barrels per day is small compared to their over-all petroleum consumption. For example, one of the largest operators in the petrochemical business has a chemical production of less than 15,000 bbl. per day, which is about 3 per cent of the company's crude-oil throughput.

Light Hydrocarbons

Next, consider natural gas and L.P.G. This is the segment of the industry likely to be more directly concerned with the petrochemical industry. In these products, we are dealing primarily with only four molecular species. Methane is in greatest abundance with smaller quantities of ethane, propane, and butane. Relatively simple processes, by chemical-industry standards, are needed to isolate the fractions of natural gas or L.P.G. for manufacture of chemical derivatives. Thus, petrochemical companies can be your direct customers. First, let us look at some of the chemicals now being made from one of these raw materials—methane.

TABLE 2—CHEMICALS FROM METHANE

Chemical—	Major end use
Ammonia	Fertilizers
Methyl alcohol	Antifreeze and raw material for formaldehyde (used in plastics)
Hydrogen cyanide	Plastics and synthetic fibers
Acetylene	Welding, vinyl plastics, and neoprene rubber
Methyl chloride, methylene dichloride, chloroform, and carbon tetrachloride	Solvents and refrigerants
Carbon black	Rubber compounding

As we go on to ethane, propane, and butane, the number of chemical derivatives becomes much greater and far too numerous to list here. Several dozen major chemical products are involved.

Many of the plants making chemicals from natural gas and L.P.G. are thirsty consumers of raw materials. For example, a single ammonia plant may consume some 8 million cubic feet of natural gas daily for a production of 200 tons a day of ammonia. A butadiene plant for synthetic rubber could use around 115,000 gal. a day of normal butane for an annual output of 50,000 tons of butadiene.

Plant location . . . Now, suppose you are a producer of natural gas and you wish to consider participating in the petrochemical field. What are some of the factors in determining whether you could attract a petrochemical plant to your location?

First and foremost, you must have an assured long-range source of supply. Chemical plants are expensive to build. Investments of 10 to 20 million dollars are not uncommon. Quite obviously, no chemical producer is interested in investing money of this magnitude in a plant that may be shut down by running out of raw materials.

Second is the value of the gas. The chemical industry is highly competitive at all levels and low-cost raw-material supplies are essential. Stability of both supply and price have been important factors in the increasing consumption of petroleum as a raw material for chemicals.

The third item is strategic location. As in the petroleum industry, freight costs are important, particularly on low-unit-value items. Consideration of each chemical project involves detailed calculations on the relative economics of transporting raw materials vs. transporting finished products. There is no single generalized answer. An interesting recent compromise is the selection of sites along large gas-transmission lines.

One case in point is the National Petrochemicals Corp.'s plant at Tuscola, Ill. It is located on the Panhandle Eastern Pipeline and is owned 40 per cent by Panhandle Eastern and the balance by National Distillers. This, incidentally, is a good example of how diversified the chemical business can be. Another plant is at Greensburg, Ky. It is jointly owned by Tennessee Gas Transmission Co. and Methieson Chemical Co., and is on the gas company's line.

Other considerations . . . If you are able to make the first three hurdles of long-range supply, low value, and strategic location, then you come to other local considerations. These would be common to any refining operation and would include such items as adequate labor supply, availability of reasonably priced utilities, and low land costs. If you can match these requirements, then you are in position to do business with the chemical industry.

Your problem then becomes one of finding an organization which has, or thinks it has, sufficient market for a large-scale low-production-cost chemical plant. It must also have a fat pocket book, a desire to gamble, and the know-how to carry the project to successful plant completion and operation. The advantage to you would be acquiring a steady customer for a good many years to come.

Two additional questions remain to be answered. Just how big is this industry likely to become, and what will it mean in terms of its consumption of crude oil and natural gas?

This year, the manufacture of petrochemicals will amount to about 30 billion pounds with a value of about 3½ billion dollars. For comparison, the total annual field value of crude oil and natural gas produced in the United States is about 7½ billion dollars. You are undoubtedly familiar with the report published by the President's Materials Policy Commission. According to their estimate, by 1975 the manufacturing volume of petrochemicals will be around 54 billion pounds. That is better than 150 per cent expansion.

What will this growth mean in terms of oil and gas consumption? Not very much. The volume of consumption by petrochemical manufacturers, in relation to total national petroleum production, is insignificant. Right now, less than 1 per cent of the crude oil and gas produced in this country is winding up in petrochemicals.

The outlook for the future, as you might suspect, is better but still relatively modest. Using the figures of the President's Commission again, their guess is that by 1975 the chemical people will be consuming about 2 per cent of total oil and gas production.

Table 3 shows the whole picture, projected at 5-year intervals.

TABLE 3—OIL AND GAS CONSUMPTION BY PETROCHEMICAL INDUSTRY
(Estimates by President's Materials Policy Commission)

	Nat. gas (M.M.c.f. per day)	Oil (bbl. per day)	Per cent of total natural gas and oil
1950	180	36,500	.68
1955	390	80,000	1.1
1960	530	116,000	1.4
1965	650	152,000	1.6
1970	760	186,000	1.8
1975	870	225,000	2.0

Conclusion

Growth of the petrochemical industry will not revolutionize the market outlook for oil and gas production. **Some** individual producers—those who are able to meet the special requirements of petrochemical manufacturers—no doubt will find it advantageous to be the suppliers of raw materials for this growing, new industry.

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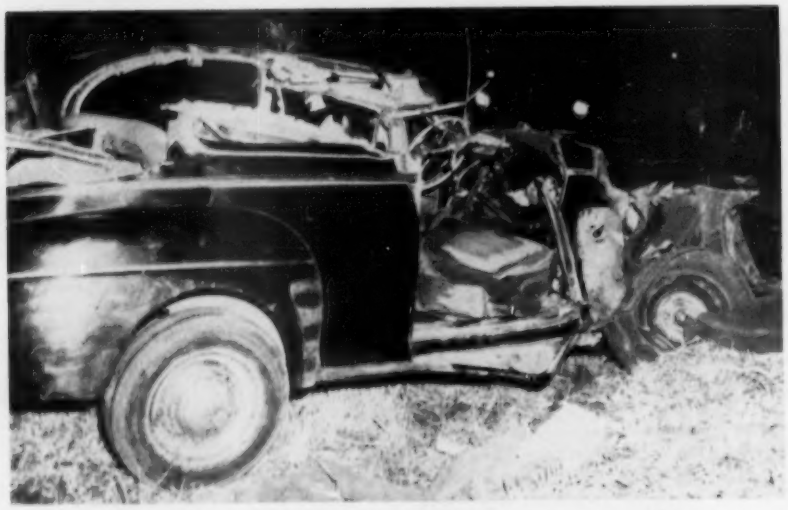
Phillips tests men whose job entails driving . . .

and inspects vehicles to insure their safety

What Oil Companies Can Do to



. . . to the end of reducing such highway scenes as this

Reduce Highway Accidents

by Stanley Learned

BESIDES the great humanitarian need to reduce highway accidents, it is just plain good business to do so. Oil companies have a greater stake in highway safety than any other business, with the possible exception of automobile companies. Our existence depends for the most part on selling products which propel automobiles efficiently and economically. Our progress depends on selling more of those products. If highway accidents continue at shocking rates, motorists will understandably be frightened off the roads, thereby adversely affecting each company's life and growth.

Author is associated with Phillips Petroleum Co., Bartlesville, Okla. Paper presented at annual meeting, A.P.I., Chicago, November 10, 1954.

Essential Preliminaries

First, we should make certain that our own motor-vehicle safety house is in order. Oil-industry drivers comprise only a small portion of the motoring public, but they are a group over which, through direct control, we can produce effective and worthwhile results. From a review of the past vehicle-accident statistical information available, it is safe to say that our industry drivers enjoy at the present time a favorable experience as compared to the motoring public as a whole. Our industrial accident-prevention program as a whole has helped immeasurably to produce this result. Nevertheless, we must have a stronger program within our industry.

Supervisor responsibility . . . An essential of a strong safe-driver program is a realization by supervisors of their responsibility in the matter. There is a tendency for some supervisors to believe that any individual can drive a car or truck safely so long as he has the proper driver's license. To improve our industrial-vehicle accident experience, each supervisor must accept as one of his most important and regular responsibilities that of close supervision of each driver under him so that recklessness and hazardous driving practices can be reduced.

Carter instructs drivers in safety methods . . .

and cooperates with local safety drives

Rules and tests . . . The safety program covering operators of company vehicles should include a carefully prepared set of rules and regulations. The safe speeds at which drivers can operate their vehicles in certain areas should be clearly defined. Hand signals should be mandatory. Each operating unit should have rules pertaining to the peculiarities of the terrain and area over which its drivers operate. But, most important, these regulations should be stringently enforced, and disciplinary measures should be taken to correct offenders. This is an area in which we can afford to be tough. We are protecting the lives of these vehicle operators.

A company's internal program should provide initial and periodic tests to examine operators' driving skill and knowledge, and their mental and physical limitations. The test should be given to every employe who drives a company vehicle either regularly or periodically. There are various types of tests available which will aid in screening out incapable drivers, and in singling out periodically those who, for one reason or another, have lost their driving skill.

Attitude Conditioning

A driver's test is a valuable tool, but it is only the beginning. It does not insure a safe driver. A man may be capable of driving safely and may know how to drive safely, but will he do so? A training program supplemented by attitude-conditioning material is the best answer I know of for getting qualified drivers to drive safely.

Training sessions should be held at various intervals at each separate company installation. One individual, preferably the immediate supervisor, should be responsible for these sessions. It is important to have safety supervisors, highway-patrol personnel, safety-council officials, local police members, and similarly well-informed individuals outside the company organization lead discussions in these training sessions.

For attitude conditioning, use can be made of such materials as driving manuals, posters, handouts, and articles in various communications media, giving factual information which will instill safety consciousness in drivers. A safe driver is constantly aware of driving hazards, and of the safe practices necessary to combat them. He must be so conditioned that his safety reflexes are triggered off subconsciously. This conditioning cannot be done overnight. It is a result of considered and constant indoctrination.

Incentives . . . Individual incentive awards for driving without an accident are valuable tools to induce truck drivers, chauffeurs, and others who drive as an occupation to operate their vehicles more safely. These people consider driving their job, and like to be cited for excellence in job performance.

However, supervisors, salesmen, engineers, and other technical persons who are not employed as drivers, but for some other skill or ability, are affected very little by incentive awards. Although they may spend much of their time driving from place to place, driving is considered only a means of transportation and not an integral part of their job.

Vehicle . . . Obviously a company vehicle which an employe operates should be in top condition. A good preventive-maintenance program for all cars and trucks, which requires that vehicles be checked at regular intervals for safe operation, is essential. It would be inexcusable if any employe were seriously injured or killed in a company vehicle because of the lack of proper inspections.

A far-reaching program will produce people who safely drive their personal cars as well as company vehicles. Properly trained drivers have a helpful effect on the entire highway-accident problem. They carry their practices into their homes and communities. Furthermore, off-the-job traffic accidents to employes are almost as devastating as those on the job. If you have invested 10 or 15 thousand dollars in an employe, you will lose it if the employe is killed on the way to a football game just as surely as if he dies after a crackup while he checks oil leases.

Advertising

Oil companies have an ideal means of pouring highway-safety information into motorists through their advertising. We have been telling people how good the products are which get an automobile going 90 m.p.h. Now it behooves us to tell them the value of slowing down that potential murder weapon. If every oil company built a 3-month advertising campaign around the theme of highway safety every 3 years, the American motorist would be constantly exposed to the highway-accident problem and what he could do about it.

This advertising should contain factual, instructive information which will increase a motorist's driving I.Q. and condition his driving attitude. Such

a program would be more than a public service.

For everybody . . . A company's internal program can be broadened to include all employes. Most company units have regular safety meetings with employes, which offer an excellent opportunity to introduce and discuss safe-driving information. It is an excellent idea to have these meetings at night occasionally, and to invite the employe's entire family to the functions.

The driving tests can be offered on a voluntary basis to all company employes and their families. Oil-industry employes should constitute the lead battalion in this battle against the highway-accident menace.

Customer contacts . . . We have scarcely touched the potential which service stations have to improve highway safety. Here our audience is assured. Here we meet the motorist face to face. Service-station personnel can be educated concerning their stake in highway safety, and can be furnished advice and materials with which to improve it. Service-station personnel should be constantly aware that it is their job to spot-check automobiles for unsafe conditions.

To send a car off the drive with a dirty windshield, for instance, would be a highway-safety sin. These men can help the motorist evade accident situations by warning him of poor roads, bad curves, icy pavements, storms, and other unsafe conditions on the roads ahead. Posters and signs with safe-driving hints can be effectively placed at various spots about the stations. Distribution of dashboard stickers and handouts can be used to help condition motorists' driving attitudes.

Customers would appreciate such services as these. Every company needs to explore further service stations as effective tools for improving road safety.

Oil-company personnel have the reputation of being leaders in community affairs. As such, there is much they can do toward reducing the alarming highway-accident statistics. Like almost every enigma in American life, the highway-accident problem can best be solved at the local level.

For our youth . . . One important action we can take in our communities is to promote driver-training classes for young people and adults. The automobile manufacturers and dealers now have in operation a worthy program to support driver-training courses as a part of the high-school curriculum. Under this program a car is made available free to all high schools which offer driving training to their students.

This growing program reaches a group which adds more than its share to the cruel highway-accident figures. Drivers under 25 years of age are involved in 25 per cent of all fatal accidents, but make up only 15 per cent of automobile operators. Driver training should be a mandatory subject for all high-school students.

Other Community Participation

Oil companies and their representatives in the community should also support the various local, state, and national safety organizations which are, in most cases, straining every muscle to control the street and highway accident plague.

Many communities periodically sponsor safety campaigns which oil-industry employes should push vigorously. They should work with city officials, safety councils, and civic bodies in organizing and actively supporting studies and solutions of traffic-safety problems in the local communities. With the broad safety training they get in their companies, petroleum workers are the best-equipped to work in these community safety projects.

A number of our larger cities have begun a program to further safe driving, which we might push for adoption by other communities. The problem drivers are given a choice between attending night-driver training classes or receiving heavy sentences for their violations. The classes include lectures by police officers, judges, and teachers; motion pictures and slides showing causes of accidents; "limited" psychiatric and medical examinations; and training designed to analyze and correct driving habits.

Law enforcement . . . Another area which needs far more consideration by oil-company employes is that of enforcement of highway laws. It is a sad fact that local police and state highway-patrol agencies cannot adequately enforce highway laws because they are not backed by the local citizenry. These men are understandably unenthusiastic about doing their duty in every traffic case when they feel most people are not in sympathy with what they are doing.

Through every educational means we should tell our employes that these men are guardians of their lives, and should be backed to the hilt.

Top-Management Support

Most of the suggestions so far have related primarily to driver education and training, because driver error is the cause of the largest number of highway and street accidents. It is not necessary to stress all of these ideas at once in order to have an effective program. In fact, it would be better to concentrate on one phase at a time rather than support weakly a number of activities.

Cooperation of top management is essential to the success of the program. Management and staff people must give wholehearted, active backing to their company's campaign, or it will never take root and grow among the rest of the employes.

Also, those who are in the vanguard in the battle against vehicle accidents must be consistent. For a supervisor to campaign vigorously for highway safety at a meeting, then drive his car 90 m.p.h. on the way home, would be sheer hypocrisy which could ruin everything he was trying to do to promote safe driving among others.

Adequate roads . . . Some accidents are a direct result of poor roads. We would be spinning our wheels if efforts to improve safe driving habits were canceled out by a poor and dangerous road system. To handle increasing traffic, old roads must be repaired, hazards removed, and new roads built, or we shall never completely win the battle against traffic accidents.

It seems clear that pay-as-you-go roads offer the only hope for immediate construction of adequate highways. Short of an exorbitant increase in taxes, they are the only means of raising our highway standards. Some of the toll roads which have been built, with adequate checks on high speeds, have already resulted in lower accident rates.

For instance, Oklahoma's Turner Turnpike, during its first year of operation, had a fatality rate of 4.25 per hundred million vehicle-miles. The national average for all highways and streets for 1952, the latest figure available at the time the Turner Turnpike Commission made its report, was 7.3 fatalities per hundred million vehicle-miles, almost twice as high as the turnpike rate.

The Rewards

Oil companies should set an example in improving highway and street safety. They owe it to their customers, their employes, and themselves. Individually, and as a group, they should do everything within reason to train drivers, install in their minds a continual awareness of highway hazards and safe operating practices, back enforcement of traffic laws, and promote better roads.

If they do these things, other industries will soon join them. Such an industrial team, combined with local, state, and national organizations actively dedicated to advancing highway safety, could drastically reduce the shameful motor-vehicle accident rate.

How to control

Vapor-Zone Corrosion in Sour-Crude Tanks

The Authors Say:

Vapor-zone corrosion in sour-crude tanks can be controlled by design, use of resistant materials, inhibitors, or coatings—either separately or in combination. No one method has proved completely successful. We believe that considerable progress can be made in the field of inhibitors. Several available materials have shown promise, but are not generally satisfactory at present.

The use of coatings is most attractive economically; however, the manufacturer should be more critical of the materials submitted for use. Rigid inspection of every phase of a coating job by trained inspectors is a necessity for satisfactory performance. The most satisfactory material will not be effective if it is improperly applied. Likewise, a perfect application will not make a poor coating satisfactory.

In an effort to obtain more satisfactory coating jobs, it would seem desirable to direct more research toward the development of both improved application techniques and coating materials having a greater tolerance for imperfect application.

by A. H. Newberg and J. P. Barrett

CORROSION in the vapor space of tanks handling sour crude is a major problem. It plagues the producer in lease tanks, the pipeliner in working tanks, and the purchaser and refiner in storage tanks. The problem continues to defy a complete solution even in these days of constant corrosion control backed by extensive research programs.

Just 5 years ago major companies reported that complete tanks had to be replaced after only 2 years' service. New decks have been reported unsafe after only 1 year's service. Such reports leave little doubt that serious problems still exist and large financial losses accrue as a result.

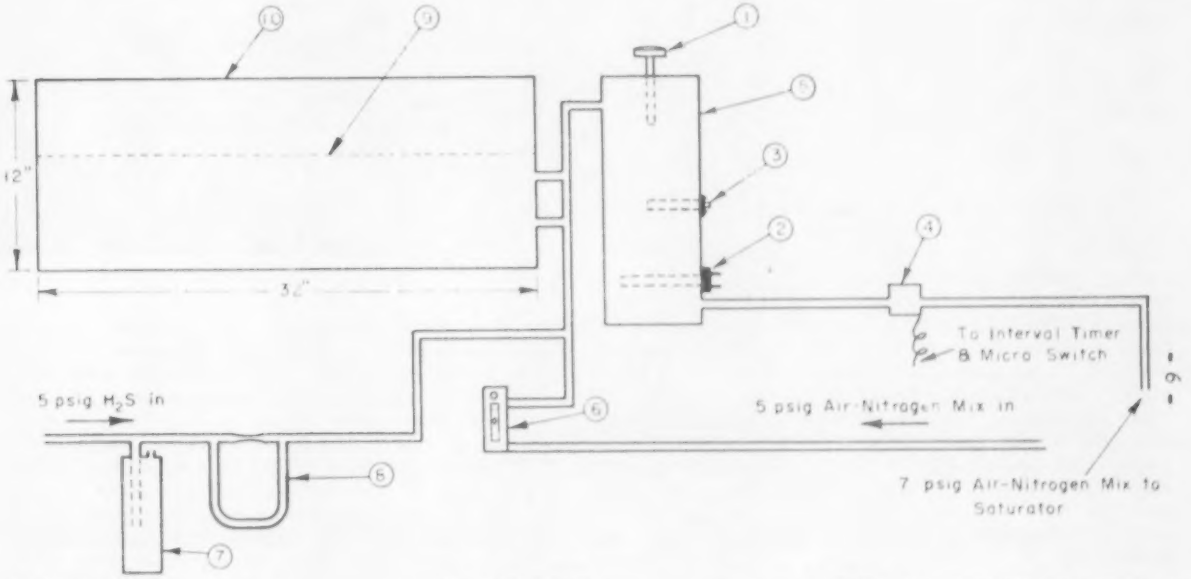
Mechanism of Corrosion

The trouble begins on the underside of the deck where hydrogen sulfide and iron, in the presence of moisture, react to yield iron sulfide and free hydrogen. As iron sulfide scale begins to accumulate, the trouble is aggravated by galvanic action between this scale and the deck material.

As these reactions progress, the scale builds up to a point where flexing of the deck will cause pieces to break free and fall to the bottom of the tank. Now we have another problem brought about by galvanic action between this scale and the bottom of the tank, which frequently results in deep pitting.

In normal tank operation, considerable air is present in the vapor zone. The oxygen accelerates the total corrosion by introducing oxidation corrosion. The combination of oxygen and hydrogen sulfide causes an extremely aggressive type of attack. The scale build up is more rapid in this system than in straight hydrogen sul-

A. H. Newberg is associated with Service Pipe Line Co., Tulsa, and J. P. Barrett is associated with Stanolind Oil & Gas Co., Tulsa. Paper presented at annual meeting, A.P.I., Chicago, November 9, 1954.



1. Thermometer.
2. Immersion heater.
3. Thermoregulator.
4. Magnetic valve.
5. Saturator tower fabricated 6 or 8-in. i.d. pipe and insulated.
6. Flow meter with valve mounted integrally with meter.
7. Constant-pressure-head apparatus. Graduated cylinder satisfactory.
8. Orifice for controlling H_2S supply to system (glass).
9. Panel supports.
10. Test box proper, 32 by 24 in. by 12-in. diameter, made of aluminum sheet.

Fig. 1—Sulfide test cabinet.

fide, and the depth and frequency of pitting are accelerated.

It becomes apparent, then, that the corrosion in the vapor zone in dependent upon hydrogen sulfide, oxygen, and water. Also, it is obvious that a large portion of the internal bottom corrosion is caused by the action upon the deck members.

Control methods . . . From this brief discussion of the mechanism of attack, several general types of corrosion control become evident. These can be broadly classified into: (1) design (including proper selection of materials), (2) inhibitors, and (3) coatings.

Design is probably the most effective method to combat this attack. The elimination of vapor zone, either in whole or in part, would be the ideal method. The trend to replace cone roofs with floating roofs is a fine example of designing to prevent corrosion. Possible redesign of the shape of internal structures to prevent liquid (water) traps would be economical, either alone or in combination with other methods of prevention. Designs have been suggested to reduce vapor exchange in order to reduce the corrosion rate. To date, these attempts have been disappointing because **complete** exclusion of sulfide is necessary to retard attack.

The use of resistant alloys has been limited by their high cost. However, in small tanks (500 to 1,000-bbl.) aluminum-alloy decks have been very successful. A new approach has recently received considerable attention. This is the use of rigid reinforced plastics. Certain of these materials have the strength and other necessary qualifications; however, no long-term data are available to prove their merit.

Inhibitors have been widely used in pipelines, production, and refinery equipment. In these systems the corrosion is generally in the liquid phase, which simplifies the movement of the inhibitor to the corroding surface. Effective inhibitors are more easily found for these systems, since we are normally dealing with only one corrodent. There has been, in the past 10 years, considerable investigation of the use of gaseous materials as inhibitors for tank vapor-zone corrosion. While these materials have not been completely successful, they are worthy of more development.

Coatings

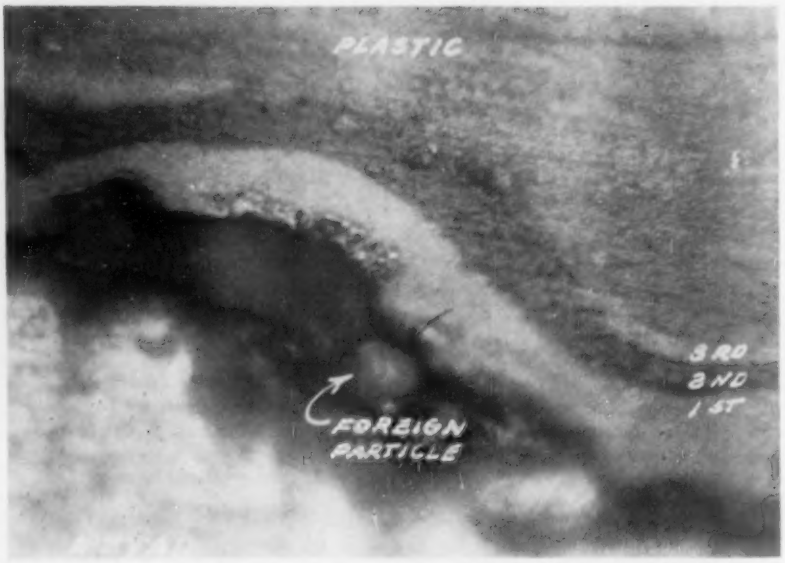
The most widely used method of controlling vapor-zone corrosion has been the application of organic coatings, especially in existing structures that have to be converted to sour-crude service. This method holds the promise of elimination of costly redesign and has a low cost (per square foot per year) of steel protected. Since coatings are so widely used in this service, it would be well to consider carefully this method of protection.

In order to obtain the most protection for your coating dollar, it is essential that the proper material be selected for the job and that it be properly applied. The proper selection of a coating can be greatly facilitated by laboratory testing.

The effectiveness of a coating system depends on two main functions: its ability to seal the metal from the corroding agent (hydrogen sulfide and water), and its ability to inhibit corrosion if the corrodent does permeate the film.

To form an effective seal, a coating must be: (1) Continuous (free of holes or breaks), (2) impermeable to hydrogen sulfide and water vapor, (3) adherent to the base metal and coherent to itself, (4) chemically inert to hydrolysis, hydrogen sulfide, and oxidation; and (5) resistant to deterioration from temperature.

The continuity of a coating is a function of its wetting properties. If the coating does not flow on clean



Fif. 2—Here the contract called for three coats of material to be applied at a coverage rate specified in square feet per gallon. Three coats can be seen as a gray-black system. Fig. 3 shows the surface of the same system.

Fig. 3

SPECIAL STRUCTURES for the Petroleum Industry

A reactor-regenerator, catalyst hopper, corrosion resistant tank, or any welded steel plate structure that the petroleum industry may need can be engineered, fabricated and erected by Chicago Bridge & Iron Company. Our four strategically located plants have complete facilities for X-raying and stress relieving to code requirements and pickling and painting fabricated shapes and forms. Experienced engineering, fabricating and erecting departments are ready to help meet any problems or requirements you may have.

Information, estimates or quotations on welded steel plate structures of any sort may be obtained by writing our nearest office. CB&I engineers will be happy to assist you in any plans or specifications that may be needed.

Right: A 9-ft. diam. by 39-ft. reactor-regenerator built by Chicago Bridge & Iron Company for the Louisville Refining Company, Louisville, Kentucky.

CHICAGO BRIDGE & IRON COMPANY

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PENNSYLVANIA

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Birmingham, 1 ..... 1536 North 50th St.
Boston, 10 ..... 1025—201 Devonshire St.
Chicago, 4 ..... 2128 McCormick Bldg.
Cleveland, 15 ..... 2204 Midland Bldg.
Detroit, 26 ..... 1514 Lafayette Bldg.
Houston, 2 ..... 2119 C & I Life Bldg.
Los Angeles, 17 ..... 1523 General Petroleum Bldg.
New York, 6 ..... 3347—165 Broadway Bldg.
Philadelphia, 3 ..... 1615—1700 Walnut Street Bldg.
Pittsburgh, 19 ..... 3228 Alcoa Bldg.
Salt Lake City, 4 ..... 525 West 17th South St.
San Francisco, 4 ..... 1554—200 Bush St.
Seattle, 1 ..... 1325 Henry Bldg.
Tulsa, 3 ..... 1606 Hunt Bldg.

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"The properties of a coating can be readily determined in the laboratory by properly designed tests. All likely materials should be screened by these tests before proceeding with expensive field tests."

metal, a uniform film will not be formed.

Generally, the lower the permeability to water and hydrogen sulfide, the better the corrosion protection afforded. By the addition of pigments, the permeability of a resinous vehicle can be changed appreciably. Pigments, which are not attacked by hydrogen sulfide, should be used.

Adhesion is the bonding of the coating to the base metal. The development of special primers has been very important in securing better metal-bonding properties. Cohesion is primarily a property of the coating itself, which denotes the toughness or elasticity of the cured-paint film.

Laboratory evaluation . . . The properties of a coating can be readily determined in the laboratory by properly designed tests. All likely materials should be screened by these tests before proceeding with expensive field tests.

A special test cabinet (Fig. 1) can be used to determine readily whether the film is resistent to attack by hydrogen sulfide and whether the film is impervious to the gas. The coated panel is subjected to cycles of moisture condensation and drying while in an atmosphere of hydrogen sulfide and air.

This piece of equipment has been in use for 5 years. The results obtained in this test have been correlated with the same system in field tanks, and it appears that a 24-to-1 acceleration ratio is obtained.

Standard hydrocarbon solubility tests are also easily run, as are tests for flexibility and adhesion.

The use of a moisture-vapor transmission test is of great value. In this test the coating film is used to seal a container of calcium chloride desiccant. The sealed container is then exposed in a constant humidity cabinet, and the passage of moisture through the coating film is determined by weight increase.

The cost of laboratory testing is only a fraction of that of field testing, and it is disturbing that the major producers of protective coatings have not utilized such test procedures to evaluate their coating for this service. Instead of being offered materials screened by tests of this type, we are urged to use a certain coating because it has given good serve in coating milk buckets, wine tanks, or cement floors. We have repeatedly been approached by coating salesmen urging us to use materials, which upon laboratory testing, proved to be ineffective in sealing metal from hydrogen sulfide and water.

Application

It should be pointed out that laboratory testing of coatings is designed to test only the coating materials themselves. The very best coating would be ineffective without proper surface preparation and proper application.

The importance of surface preparation cannot be over stressed, particularly where old tanks are concerned. All surfaces must be cleaned of all corrosion products and mill scale and must be thoroughly dry. Experience has shown that sandblasting is the only satisfactory method for achieving these results. The grain size of the sand is extremely important. A coarse sand will result in deep anchor patterns that require excessive film thickness. According to Leibman,* the anchor pattern depth should not exceed one-third of the total thickness of the entire paint system, if a good anchor and optimum film are to be obtained.

Application of the selected coating material in a uniform and continuous film of the specified thickness requires a high degree of manual skill. In addition, proper equipment must be used and kept in good working order. Competent supervisors and thorough inspection of all phases of the operation are essential.

Spraying techniques are now most widely used in tank vapor-zone coating work. Spray-equipment manufacturers normally offer advisory service on proper nozzle setups, pressures, etc., for spraying any given material. Such service should be fully utilized when organizing a coating operation. It may seem elementary to offer a word of caution about equipping the spray gun with the proper tip, needle, and air cap for the material being used; however, we have observed operators using siphon nozzles on pressure-type systems and internal atomization where external atomization is required for proper operation.

A supply of clean dry air is important for spraying. The air receiver on the compressor should be "blown down" at frequent intervals. An extractor should also be used in the supply line to remove oil and moisture from the air. Too often an operator, while not allowed to spray when moisture is on the steel, will, by improper equipment operation, apply considerable water with the paint.

Dry spray caused in part by holding the gun too far from the work is a very frequent cause of coating failure. "Arcing" the spray gun has cost operators thousands of dollars in premature failures. In numerous jobs the exact path of the spray gun can be traced in the failed coating.

Thinking in terms of number of coats and giving little attention to film thickness have contributed to many failures. This is shown in Fig. 2.

Upon investigation of this failure, it developed that the manufacturer had given a coverage rate for smooth, nonblasted steel. The coating, however, was applied to pitted sandblasted metal. The trouble was further aggravated by the excessive thinning required to spread the available material over the greater surface area. Although we had repeatedly obtained 1 to 3 mils per coat with the material in the laboratory at the specified coverage rate, the contractor had obtained a total film thickness in three coats of only 0.75 to 2 mils. This same material, properly applied, is still giving protection in several tanks after 5 years.

Coating Methods

The common deficiencies in spraying techniques described herein emphasize the need for improved application methods. Such methods should assure good control of film thickness and continuity, even when only average manual skill is available for such work. The use of roller coaters offers promise in this respect and should be developed further. Look at the excellent jobs housewives are now doing in applying wall paints with rollers! The principles involved are quite similar.

The use of "hot-spray" equipment is also worthy of further development in the application of the newer plastic coatings. This method reduces the material to spreading consistency by heating, as opposed to thinning with solvents. The material may thus have a higher solids content and a resultant increase in dry-film thickness per coat. Reduction in the use of solvent thinners is desirable because the corroding agent can always enter where the solvent leaves in the curing process.

Acknowledgment

The authors wish to acknowledge the assistance of R. M. Carter, tank superintendent, Service Pipe Line Co., in preparing the material dealing with coating application.

*"Surface Preperation Values and Sandblasting Economics," Corrosion Vol. 6, No. 5, 151-157, May 1950.

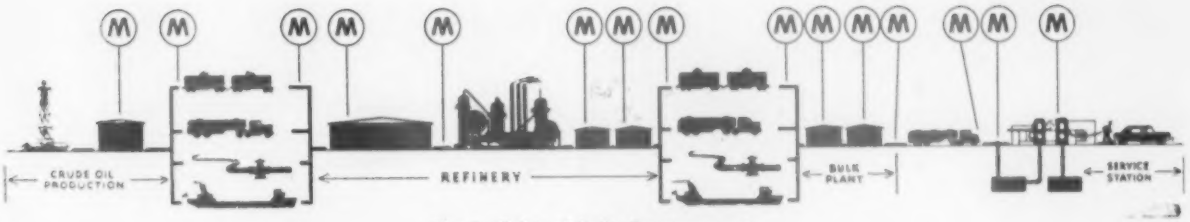


Fig. 1—Points of bulk-oil measurement.

Where We Stand on Bulk-Oil Measurement

Stock loss and fire hazard can be reduced through minimizing hand operation, training of personnel, and simplification of procedure

THE value of crude oil and petroleum products measured, sampled, and tested each day amounts to many billions of dollars. Therefore, it is essential that most economical accuracy be maintained. It is necessary that simple standard procedures be established and followed rigidly.

The trend should be toward the minimizing of manual operation insofar as practical. Many of the present methods of measuring tend to increase the stock loss and fire hazard. Although the present methods continually are being improved, there is still much to be done toward simplification.

Even more important is the training of the men who are entrusted with measuring, sampling, and testing. Today's problem is field vs. laboratory application of the methods now used. Inasmuch as an error in the calibration of a meter, in the strapping of a tank, or in the preparation of the capacity tables will be reflected in results each time a measurement is taken, it is imperative that extreme accuracy be attained in obtaining the basic measurements and in preparing the tables.

Each fundamental measurement — such as gaging, temperature reading, sampling, and the like — should be studied carefully with a view toward simplifying the procedure, reducing the time required, and increasing the accuracy of the results.

Importance of Measurement

Approximately 8,000,000 bbl. of crude oil and resulting refined products of about the same volume are measured and remeasured daily in the United States. The volume involved in a single transaction may vary from a quart of lubricating oil to a 250,000-bbl. delivery to a tanker. The number of measurements necessary in a single day's operation is almost beyond comprehension (see Fig. 1).

Purchases, sales, and exchanges totaling 70 billion dollars at a minimum well may be involved during 1954. The dollar part of these trades can be counted precisely. Accuracy of the quantities depends upon measurement practices. Therefore, it is worth while to continue to seek the best measuring accuracy which can be obtained economically.

Oil losses . . . Losses of petroleum and products are estimated to amount to approximately 350 million dollars in 1954. This will occur in thousands of locations, and in comparatively small amounts individually. Many losses occur as too small a percentage of throughput to be located or evaluated accurately by present measurement procedures. Any improvement of our ability to measure could accelerate the development and evaluation of loss-reduction practices.

Reduction in capital outlay and in working capital could be made in many cases by substitution of other methods for tank-gaging measurement. This change also can reduce shipping costs by reduction of turn-around time of ships.

Departure from specified procedure probably causes as much of any existing error as the accuracy limitations of the methods of measurement. However, as present methods are largely manual, human error will be a limiting factor to improved accuracy so long as these manual methods are used.

Present methods of measurement involve a large amount of expense and labor. Additionally, millions of dollars are lost and the quality of product is reduced as a result of the escaping of volatiles from open hatches during gaging. This also results in increased fire hazard.

At the outset it may be well to consider also the pros and cons of the academic vs. the practical approach. Briefly, the academic view is to include all points which bear directly on the given problem under available theories. On the other hand, the practical view is to combine the basic theory with possibilities at hand of economics, availability of manpower, equipment, time, and the like.

This necessarily involves a screening, as well as a balancing of relative results with requirements of attainment, from which then emerges an approach for day-to-day use. Therefore, the routine application developed in such a manner represents maximum simplicity still consistent with equity and accuracy requirements. This therefore should be borne in mind throughout, as the methods and ideas are discussed in keeping with industry's approach to the matter.

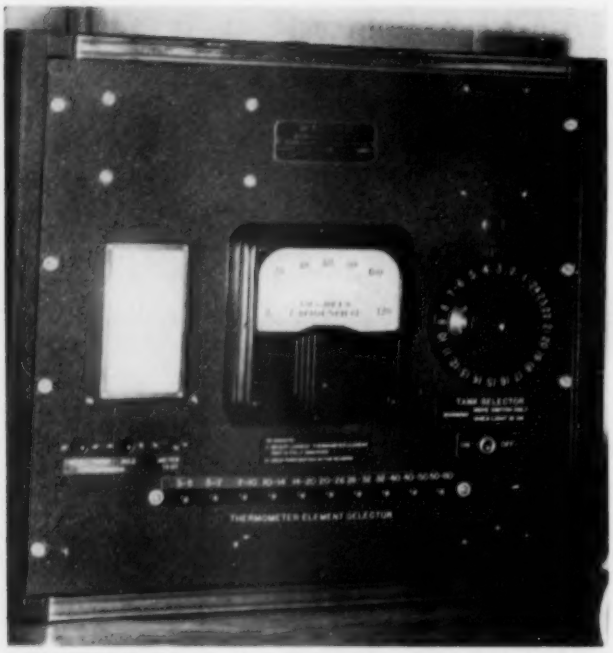
Fundamental Definitions

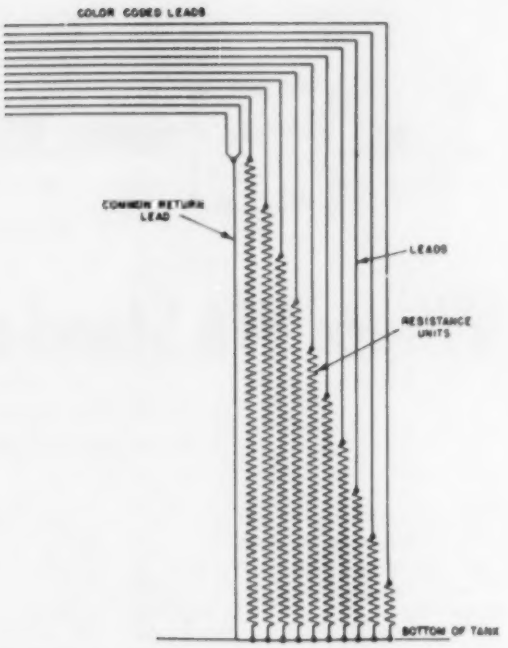
In transferring the custody or location of petroleum liquids or in valuing the inventory, it is necessary to know the quantity and quality involved. This is determined by measuring, sampling, and testing. The physical principles, and their relation to one another, are as follows:

Volume: Volume may be calculated from measurements of the dimensions of the space occupied by the liquid, if it is still, or volume may be measured by passing the liquid through a metering device, if it is being transferred.

Density: Density may be inferred from measurement of A.P.I. gravity at a known temperature. This is then cor-

This article was authored by a committee composed of the following: P. E. Frank (chairman), Sinclair Refining Co., New York; S. G. Kershner (vice chairman), Texas Pipe Line Co., Houston; P. L. DeVerter, Humble Oil & Refining Co., Baytown, Tex.; S. H. Dowdell, British American Oil Co., Ltd., Toronto; J. T. Kirk, Esso Shipping Co., New York; R. Charles Nicholson, Shell Pipe Line Corp., Houston; and L. S. Wrightsman, Humble Pipe Line Co., Houston. Paper presented at annual meeting, A.P.I., Chicago, November 8, 1954.





REMOTE-READING liquid-temperature indicator makes determination of tank temperatures easy. At right is schematic diagram of averaging type resistance bulb.

rected as required for the measured temperature.

Sampling: The selection of a portion is referred to as "sampling." The method of obtaining and handling the sample depends upon the property to be evaluated, as the sample must be truly representative of the property or condition of the material.

Testing: Qualitative numerical evaluation of a physical or chemical property is referred to as "testing." The type of test is dependent upon the property to be evaluated, and the conditions and method must be defined and followed accurately.

Selection of method . . . Field vs. laboratory-application possibilities must be taken into account early in arriving at decisions as to choice of equipment and methods applicable to the given problem. Refinements possible in laboratories are frequently impractical in the field and often impossible of application there. Simplified field methods must produce accuracy within practical limits.

Field results are those obtainable by established methods used in the daily routine and which are applicable to the mutual needs and desires of the parties to a given transaction. For instance, in field purchases and sales of crude oil, laboratory testing equipment and methods may be used generally by industry custom and acceptance in Pacific Coast territory whereas, east of the Rockies, field methods find general acceptance for the same reasons and so on in other phases of industry.

Improved methods . . . Continual improvements in measurement methods and equipment are adopted when approved. Although by no means a complete list, the following are examples of changes which have been adopted during the past few years.

1. Deep-grooved gaging plumb bob to facilitate measurement of gasolines.
2. Improved cup case for tank thermometers.
3. Approval of flushing-type case for tank thermometers.
4. Standardization of tank thermometers.
5. Approval of 3-ft. angle-stem fixed thermometers.
6. Approval of bimetal-actuated dial thermometer.
7. Approval of mercury-actuated dial thermometer.
8. Consideration and trial of electric-resistance thermometer. The write-up on this device is now published for information in the A.S.T.M. manual on Measurement and Sampling of Petroleum and Petroleum Products (second edition, p. 57, February 1953); and is approved as a revision to A.P.I. Code 25: "Code for Measuring, Sampling and Testing Crude Oil."
9. Change in specifications on pear-shaped centrifuge tube to increase accuracy.
10. Change in specifications of 12.5-ml. centrifuge tube.
11. Standardization of gaging tapes at 60°F. instead of 68°F.
12. Procedures for calibration of tanks have been improved and revised. For example, calibration methods for tank bottoms with static irregularities or flexure under load, calibration methods for expansion and contraction of tank shells with varying liquid heads, tank shell-metal temperature changes, and out-of-round tilt characteristics, and the like have been approved by the American Society for Testing Materials.
13. Volume-correction tables have been expanded and extrapolated.
14. All new, potentially applicable devices are examined by industry representatives. For instance, automatic tank-gaging devices, already used for intracompany measurements, now are approved as a revision of A.P.I. Code 25 for use whenever mutually agreed.

Measurement of quantity . . . There are two conditions under which the quantity of liquid may be measured, viz.: (1), when it is still; and (2), when it is in motion. The first and older method involves tying up extra tankage and quantities of liquid. Whenever feasible, this is being replaced by meters, enabling quantity to be measured during transfer. This reduces capital costs, handling time, and loss of product.

Volume measurements: Volume measurement of still liquid usually is accomplished by measuring the depth and the temperature of liquid in a

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container which has been calibrated in volume units. The temperature should be the average liquid temperature. Gravity also must be known or measured.

Accuracy is dependent upon the surface of the liquid being horizontal, and upon there being no movement of the bottom of the container under varying depths of liquid, unless especially compensated for. Under low-temperature conditions the surface of heavy products does not remain always horizontal, and it then is difficult to gage these accurately.

Under certain conditions water may be introduced beneath the petroleum liquid in order to indicate any movement of the bottom of the container under varying depths of product.

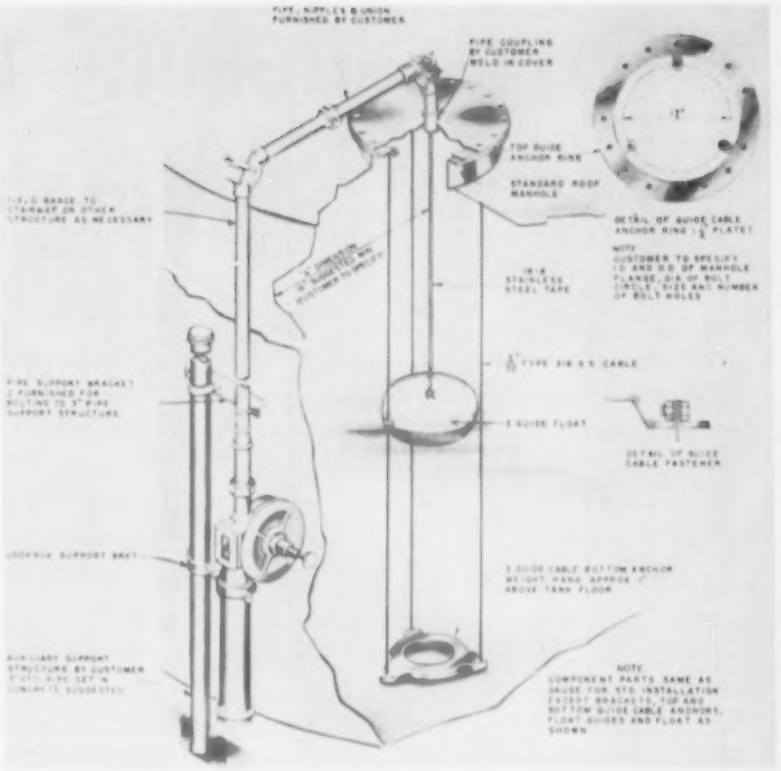
Manual gaging: Depth of liquid usually is measured or gaged by hand, using a metal tape. This involves a considerable amount of labor, and volatile products escape through open hatches during gaging. Accuracy is dependent to some extent upon the skill and thoroughness of the operator. Gage readings must be converted to volume units by use of a tank calibration table.

Automatic gages: Devices which will determine and indicate the level of liquid in a tank without using manual means are known as automatic gages. These usually are actuated by a float, but other principles—such as direct surface contact, surface sensing, and sonic vibration—also have been tried.

The use of automatic gages enables liquid depths to be determined at a central station without visiting the tank, or at least at the tank base, and without climbing or opening a hatch. The use of automatic temperature and level indicators is increasing, and it should become more desirable with any further rise in labor rates and product costs. Automatic-gage readings also are converted to volume readings by use of tank calibration tables.

Tables are required which will indicate the volume at each small increase in level for each tank or compartment of a ship which is to be gaged. These tables are prepared for tanks by measurement of the tank with a steel tape in order to determine its dimensions. In the case of ships the tables usually are calculated, and are not necesasrily exact in view of the irregular shape of the ship's hull.

It is common practice to determine over a period of time the degree of accuracy of these tables by comparison with measurements on shore tanks when fluids are being transferred. In this manner an experience factor is determined for the particular ship in a given service, or for each compartment of the ship, as required. Therefore, ship measurements may be used to give fairly accurate readings as a check on other measurements.


PIPE COUPLING BY CUSTOMER WELD-IN COVER
TOP GUIDE ANCHOR RING
STANDARD ROOF MANHOLE
DETAIL OF GUIDE CABLE ANCHOR RING
DETAIL OF GUIDE CABLE FASTENER
TANK FOOT INCH

REMOTE-READING liquid-level gage is being used to obtain more accuracy and more economy in gaging tanks.

Positive-displacement meters: Positive-displacement meters are the most commonly used in the petroleum industry. They are particularly satisfactory in the smaller sizes, but up to the present have been somewhat limited in the large sizes because of weight and cost. It is essential that they be preceded by air eliminators if there is any likelihood of there being air or gas in the system. A temperature compensating device may be added so that the meter also will read volumes corrected to 60° F.

Venturi meters: Venturi meters generally are not considered to have the accuracy required for custody transfers over the range of liquid flows which are encountered in the petroleum industry.

Meter calibration: Positive-displacement meters must be operated in conjunction with some method of proving them at frequent intervals if the best

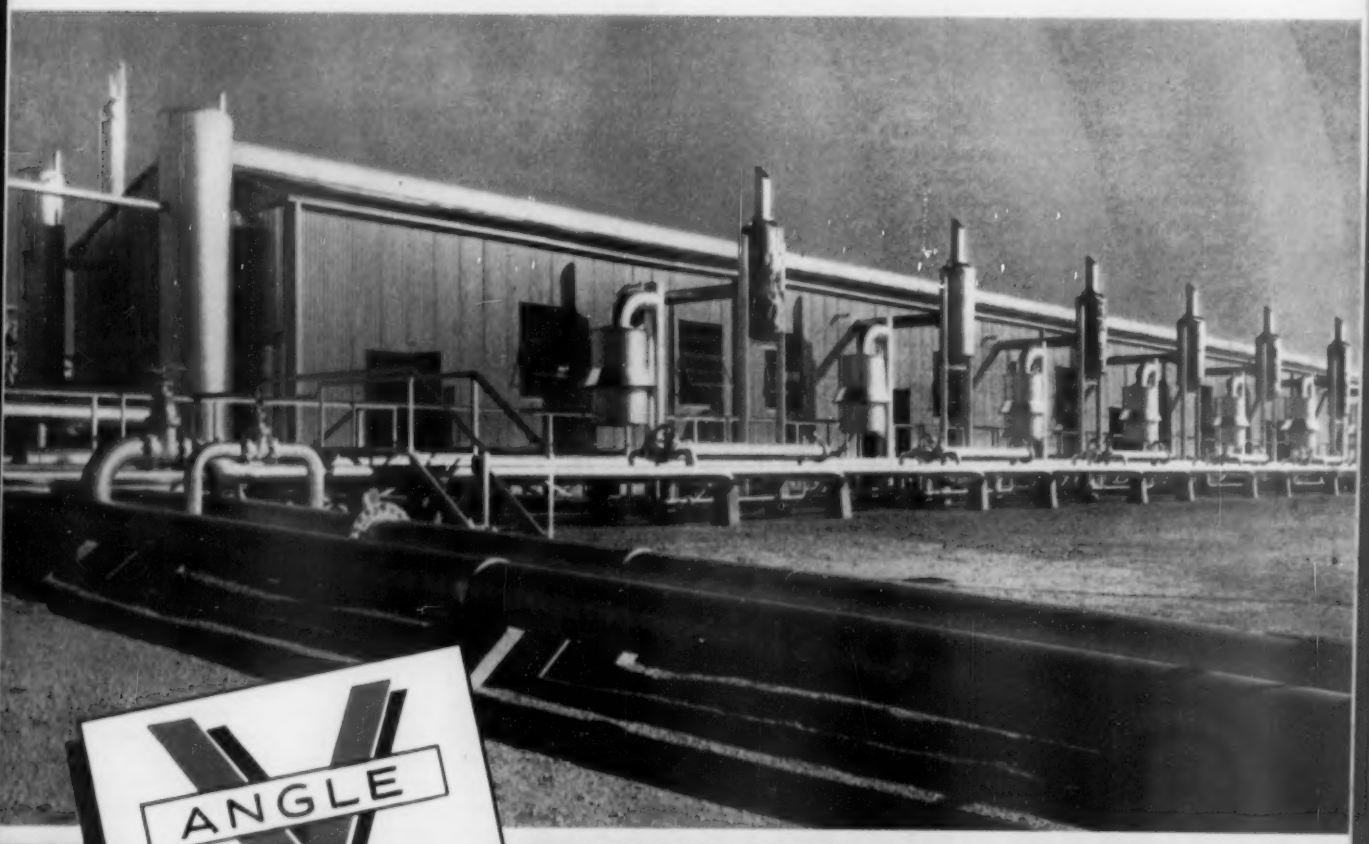
Dependability Plus ...

in the GMV story at Runnels Gas

YES, efficient, trouble-free performance. That's the experience of Runnels Gas Products Company with the eight Cooper-Bessemer GMV's recently installed at their Ballinger, Texas plant. But that's only part of the story ... expected and counted on with these modern V-angle compressors.

Runnels Gas, a subsidiary of Union Sulphur and Oil Corporation, uses these GMV's for process gas, propane refrigeration, and gas injection in this new natural gasoline plant of theirs. And they, like so many Cooper-Bessemer customers, have made a point of expressing appreciation for the detailed installation recommendations of C-B service personnel ... and also for the availability and rapid delivery of needed spare parts. This sort of cooperation is mighty important in *any* kind of engine or compressor application.

Next time your plans call for compressors up to 2500 bhp, check on Cooper-Bessemers.

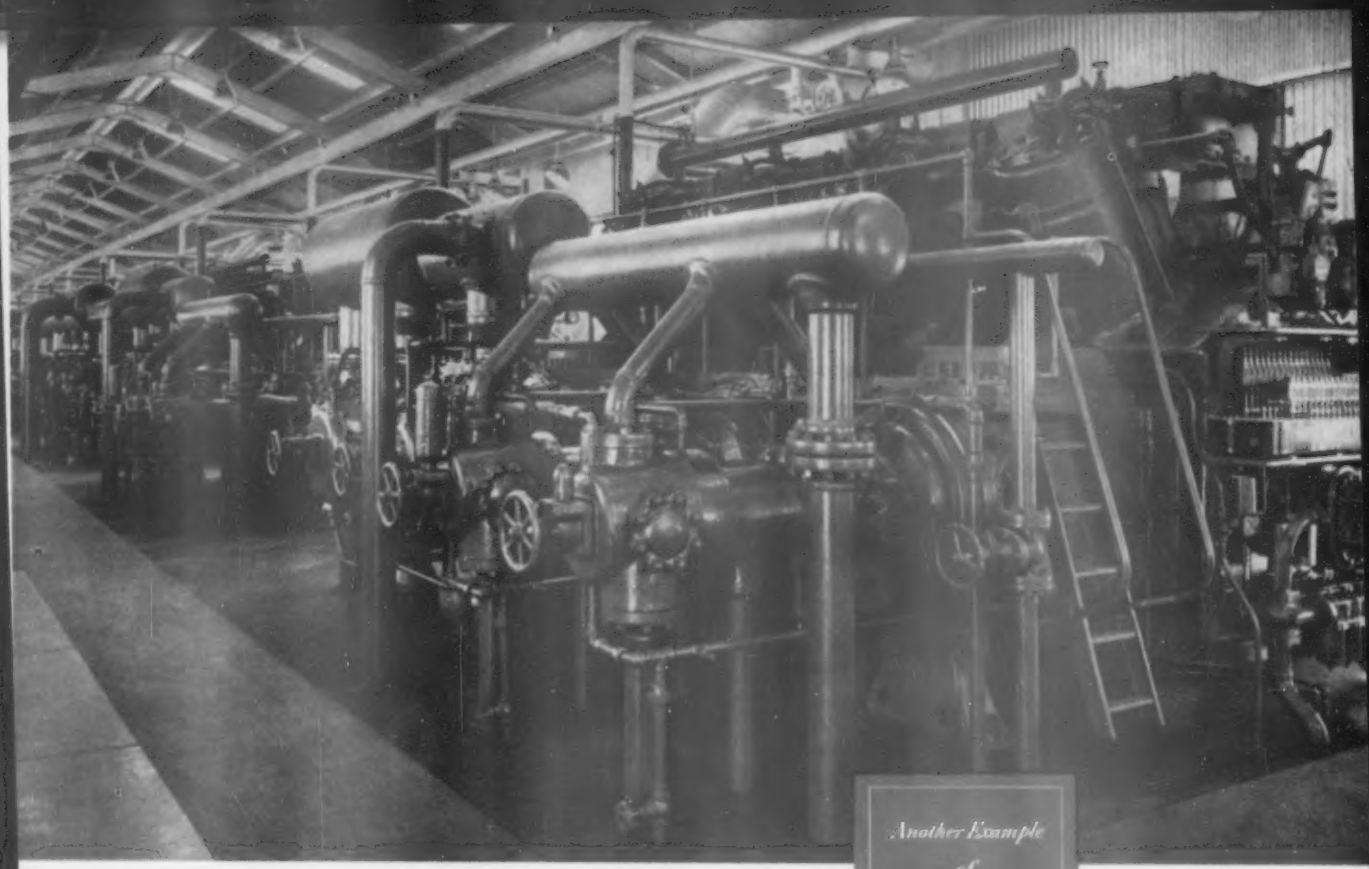


ANGLE

Compressors

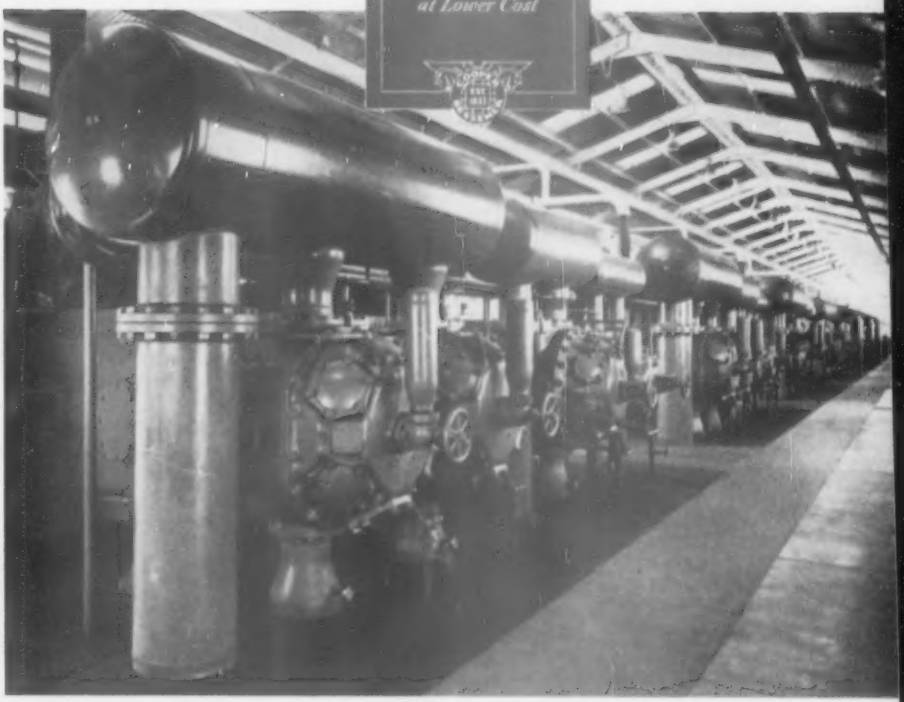
New York Washington, D. C. Bradford, Pa.

San Francisco, Cal. Houston, Dallas, Greggton, Pampa and Odessa, Texas Seattle, Wash.



Another Example of Efficient Power at Lower Cost

In the foreground of this interior view of the Ballinger station are three 10-cylinder Cooper-Bessemer GMV compressors rated 1100 hp at 300 rpm.



Line-up of eight Cooper-Bessemer 8- and 10-cylinder compressors at Ballinger, Texas. Two GMV-8-TF's are used for propane refrigeration, and injection, while the remaining six compressors are used for plant process gas.

The compact Runnels natural gasoline plant at Ballinger, Texas, contains five Cooper-Bessemer 880 hp GMV-8-TF's, and three 1100 hp GMV-10-TF's, totaling 7700 dependable compressor horsepower. The plant was designed by Messrs. F. M. Seibert and W. H. Woods of Runnels Gas.

by **Cooper-Bessemer**

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results are to be obtained. This may consist of using a prover tank properly calibrated and certified by a governmental or other competent agency. The meter also may be calibrated by use of a tank which may be weighed or by another, already calibrated, meter.

For pipelines handling various products it is necessary to prove a meter on each product and, instead of changing the meter calibration, a factor is used to correct the reading of the meter for the different amounts of "slip" encountered with each product.

Weight measurement: Measurement by weight is usually impractical because of physical limitations and cost of equipment resulting from the sizes involved. Truck-weighing scales sometimes are used for the determination of quantity of Bunker fuel, asphalt, and crude oil under certain conditions.

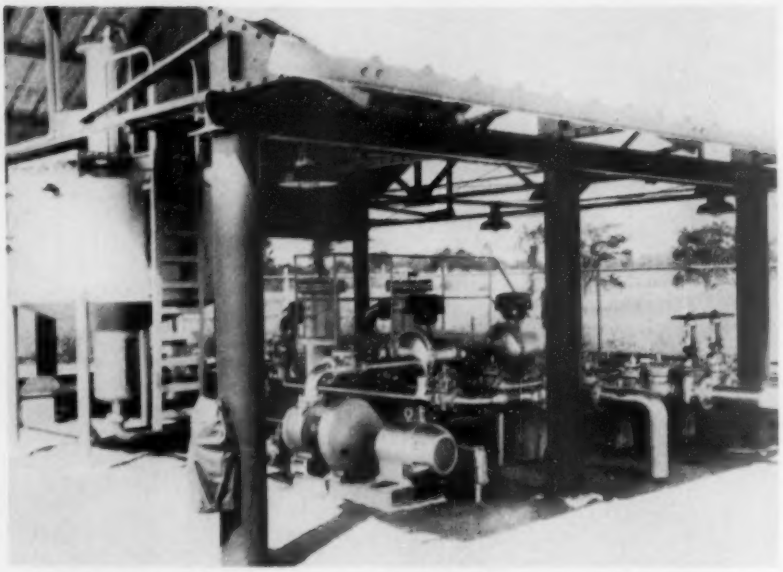
Tanks mounted on scales are used on very infrequent occasions for the loading and discharging of ships, particularly whenever the product is of extremely high value. This method is expensive and inconvenient, and its slowness delays the turnaround time of ships. The direct weighing of liquids is not adapted at present to large quantities.

Measurement of Temperature

Volume correction for temperature: Measurement for average temperature of a large quantity of liquid is difficult. Liquids tend to stratify at different temperature levels and, because of wind and sun, the temperature at different locations also will vary.

Manual temperature measurement: Present practice usually involves the use of a cup-case thermometer suspended through the gage hatch into the liquid. After this has been allowed to remain a sufficient time for the thermometer to reach the temperature of the liquid, it then is quickly withdrawn, and readings are observed at the gage hatch. Whenever liquid temperature varies considerably from atmospheric temperature, this method can involve inaccuracy.

Automatic temperature measurement: Devices which will measure and indicate the temperature of liquids without the use of manual labor are called automatic temperature devices. These are operated on several principles, including the expansion of mercury or alcohol in a bulb, a dial indicator actuated by a bimetal device, or electrical-resistance indicators. These usually indicate the temperature at one or more spots. However, the electrical-resistance thermometer has been varied so that the resistance or sensing element has been elongated to equal the depth of liquid. Thus the average resistance of this element gives indication of the average temperature throughout the depth of liquid.



PRODUCT PIPELINE takeoff station shown here is indicative of current trends.

Although it is common to specify that all temperature indicating devices be accurate to ± ½° F., which should enable readings to be obtained to the nearest degree, it is possible that present methods do not always yield this accuracy. This results from the irregularities of the human factor combined with the allowable tolerance in the instrument.

Correction of measured volume for measured temperature by the industry is made according to the A.S.T.M.-I.P. Petroleum Measurement Tables prepared in 1952. Table 6 should be used whenever there is need for correction for each degree of A.P.I. gravity of the product.

Commercial transactions and most volume corrections are made, however, based upon Table 7. The gravity range from 0° A.P.I. to 100° A.P.I. is divided into seven groups, thus greatly simplifying the table. Minor inaccuracy sometimes results from the use of this table, particularly whenever the product has a gravity which is near either end of a group. It is general practice to both buy and sell on this basis on the assumption that the errors will cancel out.

Measurement of Quality

In the usual transactions involving petroleum and its products there are two properties which are always important, viz., A.P.I. gravity, and water and sediment (referred to hereinafter as b. s. and w.).

Sampling: Sampling also falls into two main groups, depending upon whether the sample is selected from still liquid or from moving liquid. The most commonly used and recognized methods involve the taking of one or more spot samples, or a composite sample which has been removed from all levels of the liquid.

This method is limited to samples obtained directly below the hatch or from sample cocks installed through the shell of the tank.

Continuous or intermittent line sampling during movement is being developed and appears capable of giving improved results. Certain of the sampling mechanisms under development withdraw a sample from a pipeline uniformly during the time of transfer. Other devices attempt to withdraw the sample proportionately to the flow through the line. In the case of b.s. and w. there is reason to believe that the foreign matter may travel in slugs and, therefore, it is quite difficult to obtain a truly representative sample.

There recently has been some work on the direct determination of the b. s. and w. flowing through a pipeline by means of measuring the variation in dielectric constant. This would appear to be a very desirable improvement if the accuracy of this measurement can be raised to a satisfactory level, as the sampling for b. s. and w. is a particularly difficult task. Further development of sampling devices and techniques will be very useful to the petroleum industry.

Testing

A.P.I. Gravity: This is the most universal specification of petroleum and its products. The test is performed with a hydrometer, using the A.S.T.M. method designated as D 287. It is important that the sample does not cool

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Hycar has a place in power steering, too!

O-rings molded by Goshen Rubber Co., Inc. for Monroe Auto Equipment Co., manufacturers of the Power-Guide unit. B. F. Goodrich Chemical Company supplies only the Hycar rubber

BEHIND the thrilling performance of Monroe Power-Guide power steering is a unit that's a marvel of engineering design—and O-rings made of Hycar American rubber help assure its efficient, safe operation.

The Hycar O-rings are mounted on the pistons and valve spool to maintain a tight seal between these parts and the hydraulic cylinder in which they move. They maintain the proper flow of hydraulic fluid and prevent leakage around the strategic parts of the unit.

Hycar was chosen for the O-rings because it has low compression set characteristics and retains its strength and flexibility after prolonged exposure to hydraulic fluid at temperatures up to 300°F. The O-rings are molded from a Hycar rubber compound which exceeds the requirements of specifications SB-715ABE$_1$E$_3$F, SB720ABE$_1$E$_3$F and AMS 3206.

Hycar's advantages make it ideal for many jobs where resistance to heat, cold, abrasion, gas, oil and many chemicals is important. Let's talk over your product problems or requirements and see where Hycar can help. For technical information, please write Dept. HJ-12, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

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below the specified temperature during this test.

The A.P.I. gravity should be measured, when feasible, at a temperature near 60° F., but gravity and temperature must be taken simultaneously. Table 5 of the A.S.T.M.-I.P. Petroleum Measurement Tables, gives the means of correcting the gravity from that observed to its equivalent at 60° F.

For some products containing aromatics a distillation is necessary as the coefficient of expansion for aromatics does not follow the usual gravity relationship, and a different correction factor is used.

Water and sediment: B. s. and w. usually is determined by the method prescribed in A.P.I. Code 25 or A.S.T.M. D 96, method of test for "Water and Sediment by Means of Centrifuge (Tentative)."

The A.P.I. base method involving A.S.T.M. D 95 and D 473 may be used if greater refinement is required.

The field-centrifuge method and the gravity-settling method are satisfactory for use as a field test.

The basic information, upon which all transactions are made, is determined and recorded by the gager or by inspection personnel. The importance of this fact should not be overlooked.

Gaging personnel . . . Only experienced and well-trained men should be designated for measurement work by the industry. They should have sufficient interest and responsibility to take all necessary action to insure that their results are dependable. They are required to have sufficient training and experience under the guidance of a well-trained person in order to perform the operations accurately.

Testing personnel should be the laboratory-technician type of individual who has been trained in proper techniques. Test results reflect on both quality and quantity and, therefore, must be consistently accurate.

Calibration of meters, strapping of tanks, and preparation of tank-volume tables are the most exacting of all of the inspection functions. Errors in this work are always in the same direction and will be repeated many times before observation and correction. Men performing this work should have good experience and understanding in all of the functions of measuring and routine calculations which are involved.

Inspection agencies . . . Inspection agencies, such as are maintained by the Government, or by individual oil companies, or those companies whose function it is to serve the industry by inspection and measuring of petroleum products, require versatile personnel. They may be asked to perform any or all of the functions mentioned hereinbefore.

Although these companies or agencies usually maintain specialists for each of the functions, it may be that, on occasion, only one man can be sent to carry a complete loading or measurement through; hence he must be able to handle all phases of the operation.

This is an exacting business, with a large number of dollars involved, and it depends upon ability and integrity to assure that the job is done accurately, and that neither party is prejudiced. Inasmuch as the business is competitive there may, on occasion, be difficulty in maintaining personnel of suitable caliber.

There is much to recommend the further extension of uniform measurement and testing codes and practices throughout the industry. This can facilitate the transfer of petroleum and its products between companies or departments of companies. It also will simplify the training of measurement personnel. Exchange of information throughout the industry will be made easier, and this is vital to improvement of the art.

Measurement of Quantity

Gaging: There is much to recommend in the increased use of automatic gages, as this will result in reductions in labor and loss of product from open hatches.

Accuracy may be improved because movement of the liquid can be noticed as the gage moves, and an average may be taken instead of the highest reading being recorded. Remote indication can further simplify the operation of taking a field inventory, and probably can promote further accuracy in that all gages can be taken more rapidly from a central reading point.

Metering: It is difficult to evaluate all the advantages of metering, but under certain circumstances this can result in reduced capital expenditures and reduced working capital, besides the expediting of handling and processing, and thus can increase accuracy and reduce loading losses.

Temperature measurement: Present methods of temperature measurement are in need of improvement. The problem is most noticeable when hot products, such as Bunker fuel, are measured in cold weather. Automatic thermometers can yield the same advantages obtained with automatic gaging, and improvements in both should go hand in hand.

Measurement of Quality

Sampling: It would appear very desirable that the present developments of automatic sampling devices be carried to a successful conclusion, as it is often extremely difficult by other methods to obtain a truly representative sample for testing.

Testing: A new precise test for b. s. and w. is desirable as larger cargo and pipeline quantities are being handled. Differences between determinations made by two laboratories can involve large amounts of money. Development of a method of testing the total quantity for this particular property seems highly desirable if sufficient accuracy can be obtained.

Qualification of inspectors . . . Gaging personnel perform operations equivalent to cashiers or tellers in a bank, except that the values involved are often much greater. Therefore, the expense in selecting and training gagers to a desirable level of qualification can be repaid amply in greater accuracy of quantity and quality determination.

The usefulness of the qualification of commercial petroleum-inspection agencies might be further improved by inclusion of technical qualifications. These might well be specified by the American Petroleum Institute based upon its collective experience.

BOOK

THE OIL BUSINESS AS I SAW IT. By W. L. Connelly. Published by University of Oklahoma Press, Norman, Okla. 178 pp., $3.75.

In his 60-odd years as an oil man, William L. Connelly saw a lot of the oil business and the men who shaped it. This book is his recollection—an informative, interesting, and amusing recollection—of the events and people he encountered in a career that began as a roustabout in the Pennsylvania oil fields and ended in his recent retirement as chairman of the board of Sinclair Oil & Gas Co.

What Connelly saw was no sweeping panorama of the growth of an industry. But he did see the growth of an important company in that industry—Sinclair. He saw its beginnings in the driving energy and vision of Harry Sinclair and the men who helped him found his company. He saw its growth, and contributed to it, in the business ventures that expanded Sinclair's interests around the world.

In his prefacing remarks, Connelly writes: "What I personally have done or failed to do is not of consequence here, except as it throws sidelights on a stirring time in a marvelously interesting business." In keeping with that viewpoint, he has devoted most of his autobiography to others rather than to himself. He set out to contribute sidelights—and the pages of his book are bright with them. They add depth and fuller meaning to many highlights of oil history, and they explain eloquently why the oil industry was "a marvelously interesting business" to W. L. Connelly.

So this book has a double value. It tells the personal story of W. L. Connelly, the dean of Mid-Continent area oil executives. And it tells the story behind the growth of an important oil company. On either score it would merit any oil man's reading. Having both to its credit, it is a significant contribution to the literature of the petroleum industry.

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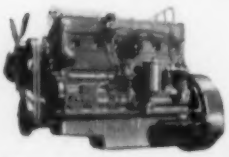

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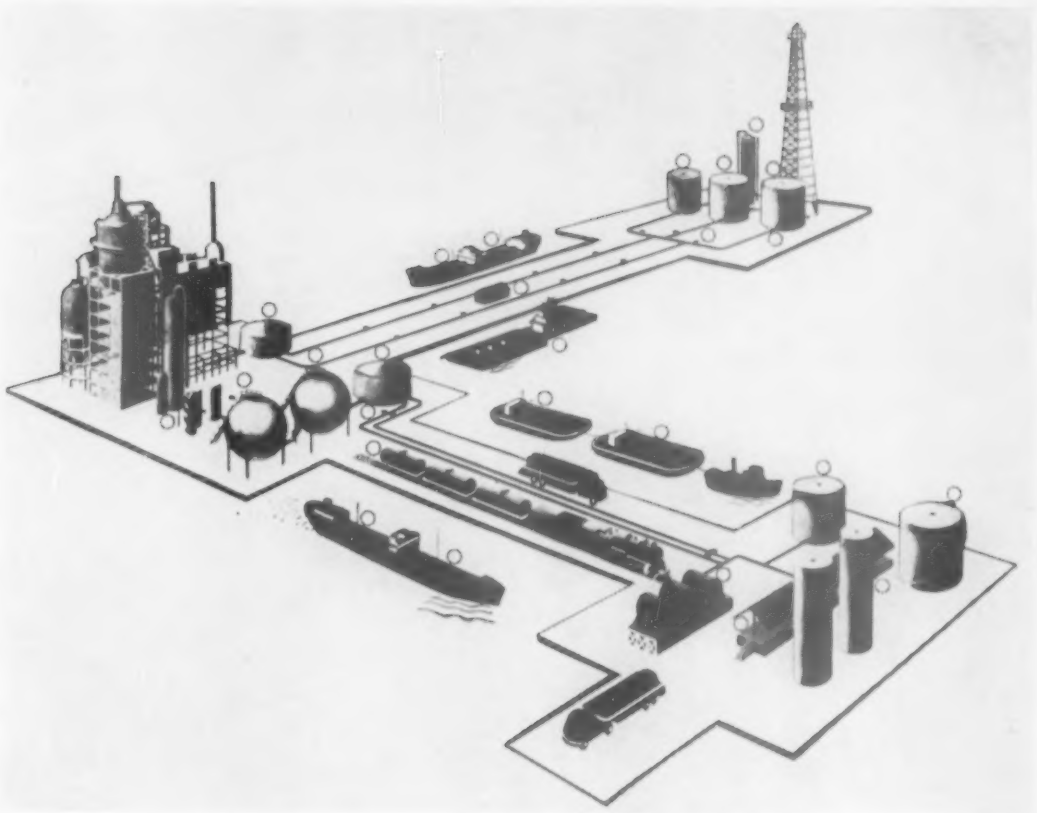


LOCATIONS on transportation flow chart where men are required. Fig. 1.

A glance at

TOMORROW'S BULK-OIL MEASUREMENT

Most operations around 1975 will be done automatically for greater accuracy

IN 1975 it is anticipated that about 60 per cent more automobiles will be on the road, and some of our own A.P.I. prognosticators predict that there will be about 65 per cent more demand than can be supplied from the present production of about 8,000,000 bbl. per day. When this estimate of the future is considered, our expanding industry must plan carefully to cope with more and more problems in the storage and transfer of bulk-oil quantities.

This article was authored by a committee composed of these men: J. H. McClintock, chairman, Esso Standard Oil Co., New York; A. E. Miller, vice chairman, Sinclair Refining Co., New York; J. G. Berglund, secretary, Standard Oil Development Co., Linden, N. J.; A. A. Buzzi, Shell Oil Co., New York; E. L. Hoffman, Socony-Vacuum Oil Co., Inc., New York; L. L. Kennedy, Esso Standard Oil Co., Elizabeth, N. J.; R. A. Martin, Standard Oil Co. (Ohio), Cleveland; H. L. Shatto, Shell Oil Co., New York, and L. S. Wrightsman, Humble Pipe Line Co., Houston. Paper presented at annual meeting, A.P.I., Chicago, November 8, 1954.

Basic principles . . . Before any discussion of future possibilities it might be well to restate the basic principles underlying our appraisal of ideas for future development:

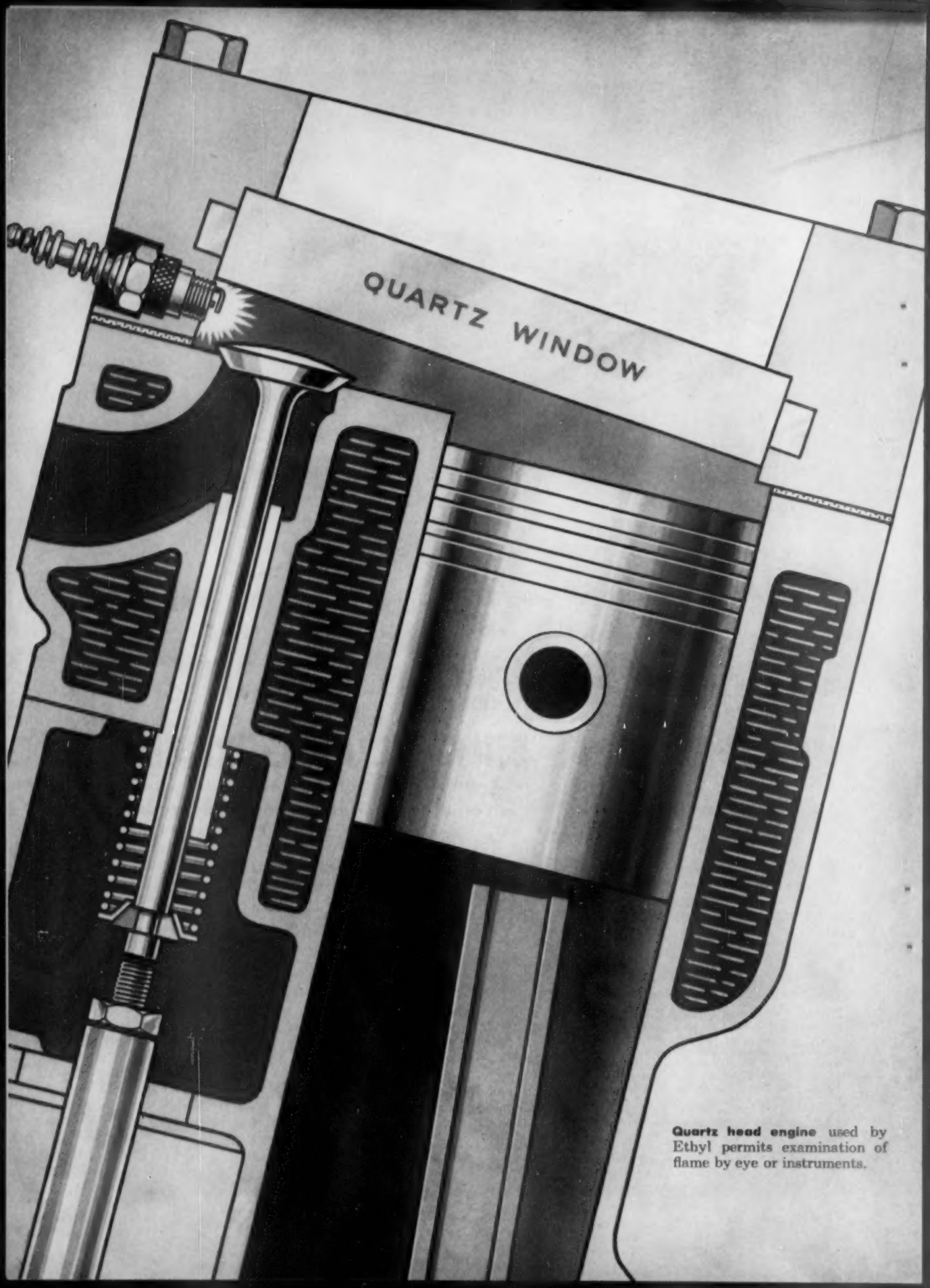
1. Sound measurement always will be the backbone of proper determination of bulk-oil losses and the only firm basis for the establishment of good control.

2. The accuracy and other advantages to be achieved and retained must be the optimum as dictated by economics.

A 65 per cent increase in demand represents almost 5,000,000 bbl., and would fill more than 20,000 tank cars daily. To say that this increased volume will require expanded storage facilities is to state the problem mildly. Perhaps the answer is in larger storage tanks. Perhaps storage plans for the future will include the use of underground facilities such as the pits and abandoned quarries which have received much study in recent months.

Perhaps we should look forward to a nonstop closed system in which the oil moves as a continuous stream from the wells to the refineries as crude oil, and then directly to the point of sale as a refined product. Because dry gas can be piped directly to the consumer, can we look forward to the day when our customers draw their requirements from metered lines at will?

Many types of measurements are now being made by electronic equip-

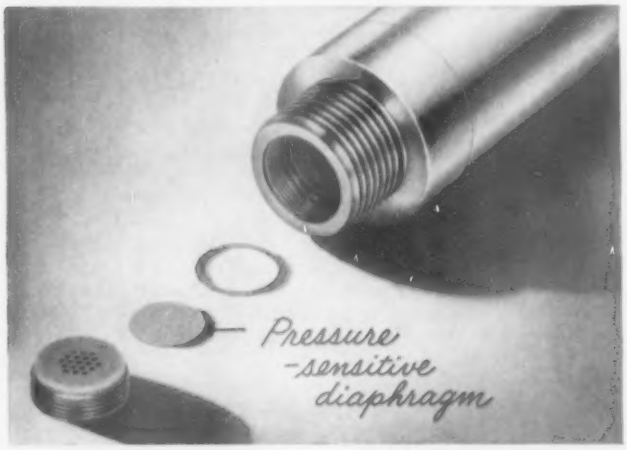


Quartz head engine used by Ethyl permits examination of flame by eye or instruments.

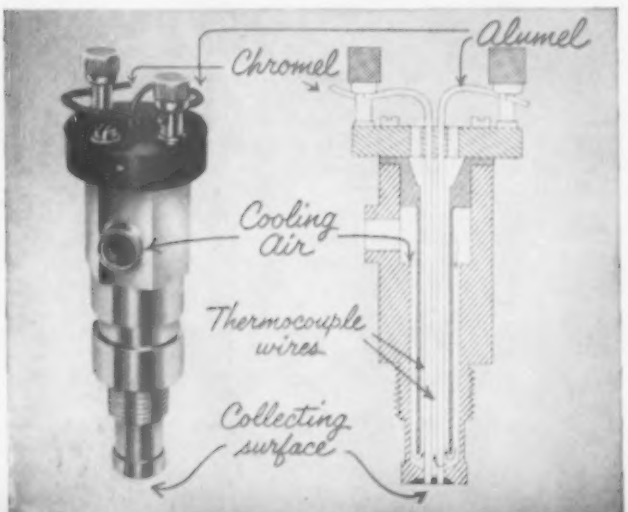
ETHYL RESEARCH TAKES A FLAME APART

to help tomorrow's engines run better

"Whirling pin cushion" designed by Ethyl people samples engine deposits as they are being formed.



Pressure indicator developed by Ethyl research accurately senses the rapidly changing pressures in the engine cylinder and sends the information to an oscilloscope for measurement.



Thermal plug mounted in combustion chamber provides a removable, temperature-controlled surface for collecting samples of combustion deposits.

LOCKED up in the mystery of how gasoline burns is a vital secret. It is known that dozens of chemical combinations are formed and broken down in the flame. But what are they?

It's hard enough to find out what goes on in a candle flame. But when you put the flame in the center of a block of cast iron and permit it to endure less than a thousandth of a second, the problem becomes even more difficult. And the difficulty is further increased since many important changes occur in the fuel as the fuel-air mixture is compressed by the piston before the flame begins.

Yet how much can be done to improve today's engines depends in no small measure on how much can be found out about this vital problem.

Ethyl research people have been working on the problem for many years in many different ways. Recently they have developed new test instrumentation and have used existing instrumentation in new ways, which show great promise in piecing together the answers.

With the help of these new techniques we may all someday know considerably more about how gasoline burns. This will help refiners to make even more effective fuels, which will permit the production of more efficient engines than are practical today.

Ethyl continues its basic research into this vital question.

ETHYL CORPORATION
Research Laboratories
1600 West Eight Mile Road, Ferndale 20, Michigan
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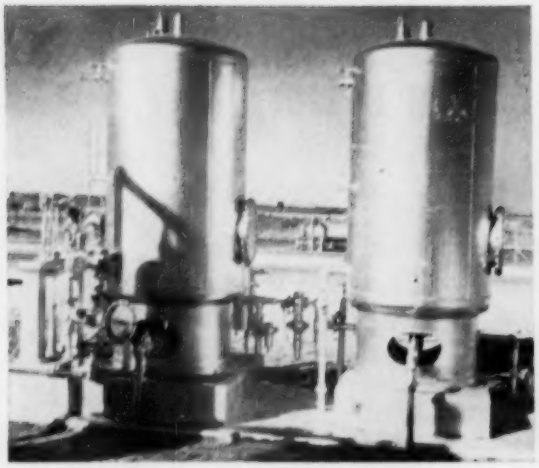
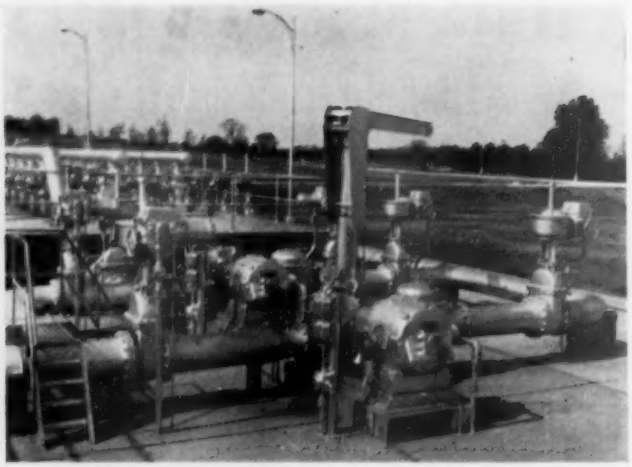


CRUDE-OIL weigh tank. Fig. 2.



PIPELINE manifold with automatic valves and pumps. Fig. 4.

A.P.I.—Pipelining

ment. There is no apparent reason why the entire measurement operation in both crude oil and refined products cannot be made wholly automatic, including the determination of net quantities, the calculation of loss data, the computation of crude-oil and gas royalties, the recording of inventory-control statistics, the compilation of yield information, and the other important end uses of the actual measurement. The results of such a development would be the immediate preparation and availability of financial statements and other operating statistical reports which are so important to intelligent management.

Various types of automatic or ground-level gages which can be equipped for remote reading already have received wide industry acceptance and may soon be used generally for measurements for custody transfer. Equipment for the automatic measurement and recording of temperature is also available and may soon be used in custody transfer. Other means for measurement of quantities may be in the early stages of development, but they are no less promising.

Work has progressed rapidly in the development of large-size positive-displacement meters, and practical applications have been made. These have obvious advantages and, with automatic temperature compensation, possibly will eliminate the need for thermal correction of volumes. The printed-ticket methods now used for meters may find use in gaging techniques.

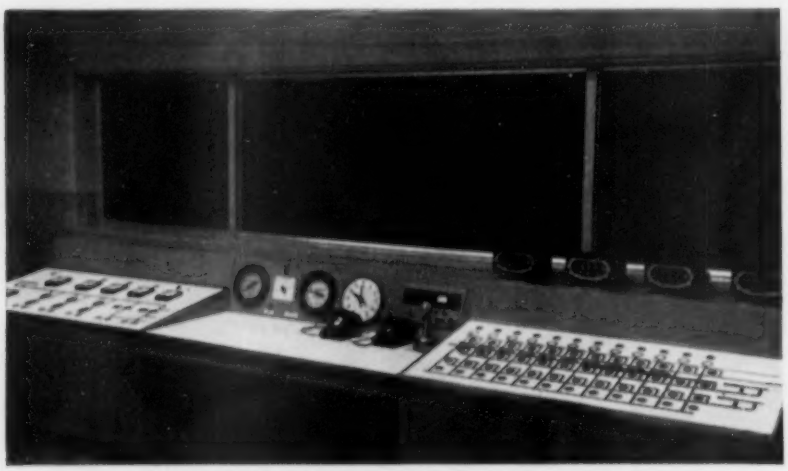
The remote gaging and temperature-measuring devices may be adapted to print or punch inventory data. Furthermore, the punch card may be useful as an order card, an automatic loading or delivery card, as well as an accounting card, all in one.

Equipment for measurement by counting equal increments of weight is under development to utilize the inherent accuracy of the beam balance. This method eliminates the error which may occur in the determination of temperature and the conversion of volumes to 60° F. One of the simpler and more conventional means of automatic measurement of quantity for automatic transfer is the counting of runs from a calibrated vessel with fixed "sensing" points for upper and lower levels. This arrangement could be thought of as a very large (for accuracy) positive-displacement meter.

Quality measurement and testing can be improved also either through reliable automatic sampling for subsequent testing for "suspended water and sediment" and gravity or through the use of instruments for determining these properties directly in a pipeline or tank. Many improved samplers are appearing on the market, and much is being done to evaluate and improve the sampling methods.

These improvements involve the location and type of drawoff tube; the integration of sample volume and stream rate; and the methods for handling, storing, and testing the sample. The measurement of gravity without sampling may be done with several instruments which either are available or are under development. These instruments measure density by determining such physical data as force on a displacement element, weight of a unit volume, pressure of a hydrostatic column, and absorption of rays from a radioactive source.

The measurement of water and sediment content without sampling is more difficult, but significant headway is being made in the development of a method based on the measurement of dielectric constant. Inasmuch as control of quality "losses" is being studied to a great extent today, it should be noted that dramatic progress is being made in the development of spectrometric and other analytical instruments



CONTROL CONSOLE of a modern pipeline station. Fig. 3.

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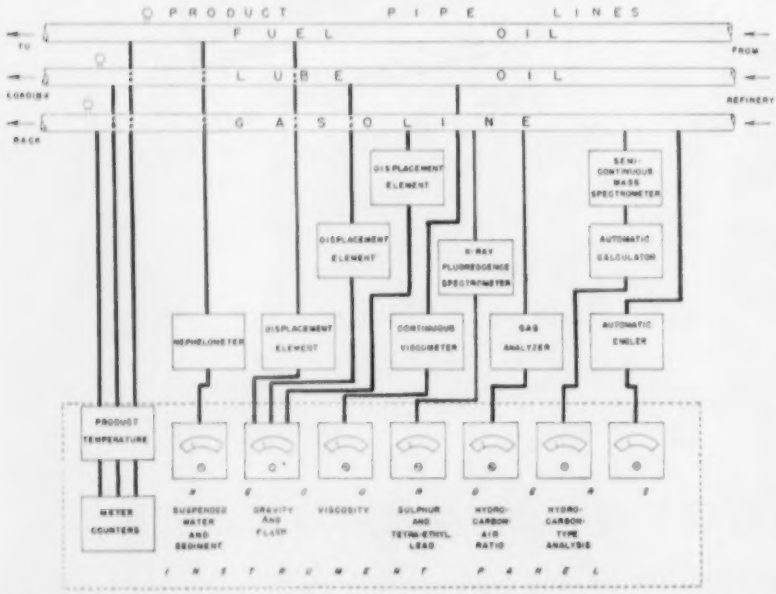
TRUCK LOADING RACK and control room of a modern marketing terminal. Fig. 5.

which can provide complete qualitative analysis of a hydrocarbon stream.

In all cases the possibilities are promising for substantial improvement in the accuracy as well as in the ease and facility of determinations. Most important of all is that progress is being made to make each of these determinations completely automatic.

When reliable automatic measurements become a reality, the way will be open for automatic and centrally controlled transfers. Work is now in progress to develop an acceptable automatic-control system for the measurement and flow of crude-oil quantities from lease-tank batteries. Although only small volumes are involved in this application, there are a large number of such batteries, and the results of this work should be applicable, in general, to other industry operations.



FLOW CHART showing battery of instruments for automatic testing of product quality. Fig. 6.

Let us consider the practicability of a composite application of these future developments. Certainly improvements in accuracy can be anticipated because of better control. Increased efficiency and manpower savings should result from the simplicity of operation. As these devices find wider use, we can also look forward to the continued improvement in the industry's safety record. If the need for intermediate storage is reduced, some of the present storage problems such as evaporation losses, accumulated sediment, water, flexible bottoms, and the like may be eliminated or at least reduced in importance. In addition, there are the capital savings which also are to be accomplished.

Consider the advantages of a system which has been integrated with an electronic calculator so that measurement can be determined directly on a net-quantity or temperature-corrected basis. The necessity for separate operations to determine liquid level, temperature, and even gravity and water and sediment may be replaced by a simple push-button operation.

Plant inventories may become a one-man one-day job. Other developments, such as automatic pumps and valves, may permit product transfer and control in a bulk terminal to be done by a single operator.

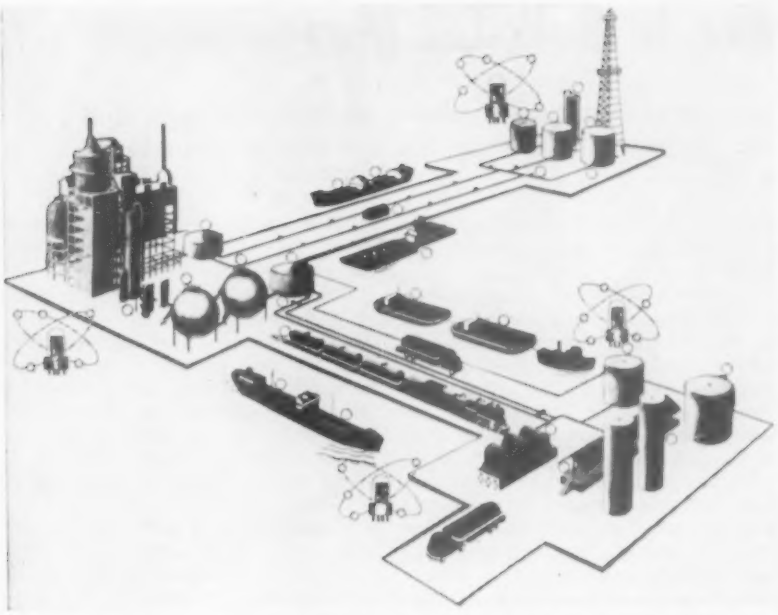
Fig. 1 illustrates the various phases of oil transportation. A number of operations must be carried out in our present practice of bulk-oil measurement each time a transfer of crude oil or product is made.

A large number of men usually is required to perform all of these duties, which involve the following: tedious and often rugged tank climbing; accurate measurement of the oil and water-and-sediment levels; time-consuming, and sometimes messy, determinations of average oil temperatures; sampling for gravity; water-and-sediment and other tests; and, finally, calculation of the quantity handled.

Our predictions are that these operations will be done automatically in the future. Many such automatic devices actually are available today.

A weight-measuring fluid meter is now under experimental development for the automatic measurement and automatic running of crude oils to a pipeline (Fig. 2).

Fig. 3 shows the control board of a modern pipeline station. The entire station can be operated from this graphic console. The motor and pump controls are on the panel at the left. At the right is a schematic diagram of



LOCATIONS on Fig. 1 showing "electronic" symbols where men have been replaced. Fig. 7.

the station manifold with the necessary valve controls incorporated into the console. Meter counters are shown in the background.

Fig. 4 is a view of the station manifold with its automatic valves and pumps.

Fig. 5 shows a modern tank-truck loading rack and its control room.

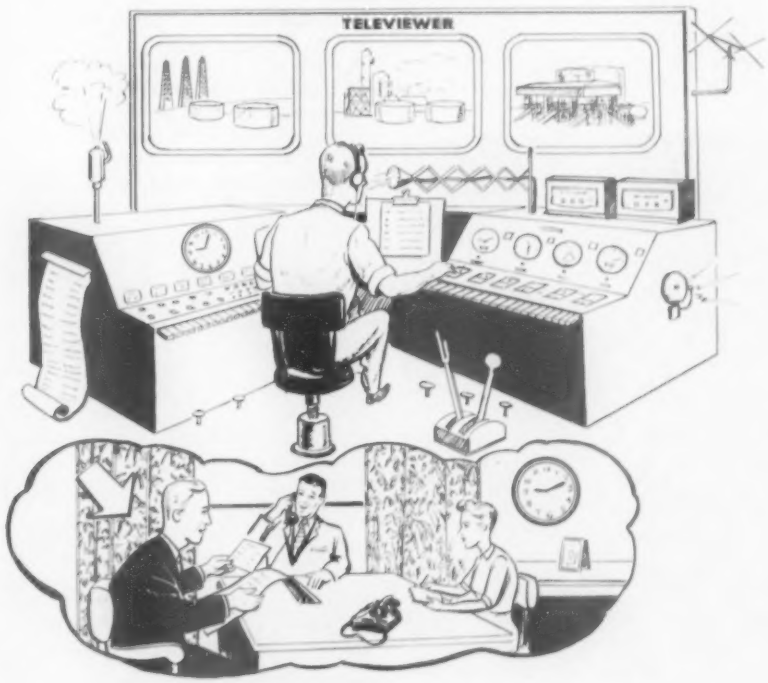
Fig. 6 is a flow chart which illustrates a possible assembly for quality control. Most of these devices are available today. The graph covers such tests as gravity, water and sediment, flash, and viscosity. On gasolines, such special tests as those for sulfur content, tetraethyl-lead, hydrocarbon-air ratio, and hydrocarbon types are possible.

Let us go back to the transportation flow chart showing the number of men required in our present operations (Fig. 1). The installation of automatic equipment can improve the picture considerably (Fig. 7).

In the interests of safety, men can be kept off stairways and tanks. Accuracy should be improved because errors resulting from the human element should be reduced—particularly those which are apt to occur during adverse weather conditions. In terms of economy, fewer men will be required to run the plant or, at least, the present manpower resources can be used more efficiently.

All of the operations for measuring, sampling, testing, and custody transfer of crude oils and products may be performed by a few men operating from central control panels.

Fig. 8 is an artist's conception of a central control panel. Note the televiewers for scanning various sections of the plant and, of course, the maze of buttons and organlike "stops" for obtaining measurements, controlling pumps and valves, and so forth. On the left is an automatic computer. The wide paper tape coming out of the slot on the side of the machine contains the final reports and statements required by management to control operations.



CENTRAL CONTROL PANEL as conceived by an artist. Fig. 8.

Conclusion

The automatic plant is more efficient and practical. In some cases meters can be installed on pipelines direct from the refinery, thereby reducing the number of tanks required for terminal storage.

The plant is safer, cleaner, and requires a smaller land parcel, which should be a definite advantage from a real-estate and tax point of view.

Our predictions are not too far in the future, and time should not be wasted if these goals are to be reached. The problems are common to the petroleum industry and can best be solved by a pooling of knowledge. We also must explore the informtion and know-how which are available from sources outside the industry, such as chemical companies, instrument manufacturers, and certain government agencies. In this way the necessary developments can be accomplished without wasteful duplication of effort.

CORRECTION . . .

In the authors' byline on the article, "Denton's New Natural-Gasoline Plant," in our Oct. 25 issue, the initials of D. W. Henwood were mistakenly given as "D. H." Henwood is resident engineer for Atlantic Refining Co., Dallas, in charge of design and construction for the Southwest.

Management's Stake in Bulk-Oil Measurement

In addition to the formulation and adoption of proper standards, oil men must train and educate the field personnel in the application of these standards.

OIL-COMPANY management quite naturally is interested in the most accurate determination of oil volumes and values. The reason for this is obvious when consideration is given to the number of transactions involved in the progress of the product from the well to the consumer. Accurate and timely determination of volumes and values is essential to the smooth and efficient conduct of business and to the preparation of operating statistics and financial statements.

Management looks to its technical staff for advice with respect to technically sound methods and procedures, and is inclined to favor the adoption of scientifically precise methods and procedures whenever the values measured justify such methods of procedure. There is a willingness to support a sound research program aimed at development of new and improved equipment, tests, and procedures. The technical staff has the primary responsibility of advising management with respect to new scientific development in these, as well as in other, areas of our business.

If the scientifically precise method or procedure is economically unreasonable in cost, then management will seek methods and procedures which will be less costly, but which will give scientifically satisfactory (reproducible) results which will be fair to all parties in all applications.

Management, through its cooperative participation in industry organizations, may well advocate single standards for any given sampling method, measurement, or test. In approving the allocation of personnel and funds for the prosecution of such cooperative efforts, management has learned by experience that it must be especially alert to the possibility, or even danger, of duplication of such efforts in different organizations, or even within the same organization—all directed to the same final result.

This article was authored by a committee composed of these men: G. H. Supple (chairman), General Petroleum Corp., Los Angeles; J. H. Peper (vice chairman), Buckeye Pipe Line Co., New York; G. P. Bunn, Phillips Petroleum Co., Bartlesville, Okla.; J. W. Foley, The Texas Co., Houston; R. A. Martin, Standard Oil Co. (Ohio), Cleveland; R. K. Paine, Standard Oil Co. of California, San Francisco; and E. O. Perkins, The Texas Co., New York. Paper presented at annual meeting, A.P.I., Chicago, November 8, 1954

Magnitude of Values

The significance and importance of the over-all function of measuring, sampling, and testing of crude oil and petroleum products have been recognized most clearly only by a relatively small number of individuals whose interests have been most closely associated with the actual possession and handling of these materials. They have been impressed by the really tremendous magnitude of the operations and the values related thereto.

The 8,000,000 bbl. of petroleum products which this country consumes daily are measured and evaluated many times in the processes of producing, transporting, refining, and distribution. On an annual basis the total values associated with the many evaluations would exceed the amount of the federal budget request which is presented to Congress annually.

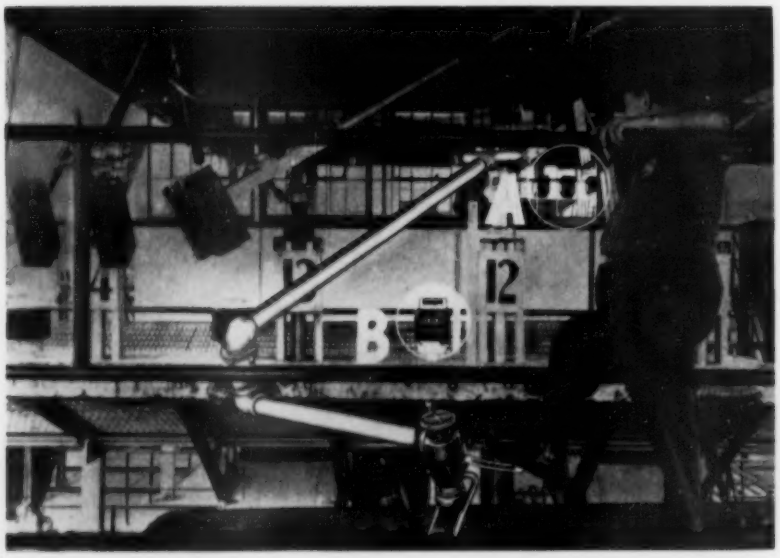
These facts have not had wide dissemination. Appreciation of their importance by an increasing number of those who may be indirectly but, none the less, importantly affected would insure a greater participation in and support of the constant effort to improve the techniques, equipment, and personnel performance related to these functions.

Historical Background

In the past there has been altogether too little recognition of the importance and complexity of the job which had to be done. First attempts at formulation of a practical and feasible program were largely on an individual basis, each unit of the industry setting up its own specifications and standards.

Out of these separate efforts there developed a great variety and diversity of methods and procedures. The need —indeed, one can safely say the necessity—for uniformity of methods and procedures of measurement, sampling, and testing developed as a result of several natural factors. Among these may be mentioned the following: the great growth and geographical spread of the industry; the greatly increased number of types of oils being discovered and flowing into commerce; and the trunk pipelines whose points of receipt often lie in an area accustomed to one method of evaluation, whereas the points of delivery might be in an area using a different set of procedures for evaluation of the same material. The latter condition also applied in the operations of the tank ship.

At about the end of the first quarter of this century, the cumulative effect of these developments brought into sharp focus the necessity for uniform methods and procedures which would be widely accepted. This dictated a



TANK-TRUCK loading by meter is simpler, more accurate than older methods.

change from unrelated, separate efforts to a common program to be participated in by those directly concerned. By this time a few units of the industry had come to a realization of the importance and complexity of the task.

Fortunately in this regard, managements had at their disposal an organization already in existence, viz., the American Petroleum Institute, which could call on the skill and experience of its members in initiating such a standardization program. The work which has been done under the sponsorship and encouragement of the A.P.I. has been guided by its general policy with respect to the development and promulgation of recommended standards and bulletins of recommended practice on measuring, sampling, and testing.

In practice, this results in the adoption, whenever available and applicable, of methods and procedures which have been developed by recognized standardization organizations, referral to such standardization organizations of matters which involve substantial interests outside the petroleum industry, and independent development and promulgation of recommended practices which involve primarily intra-industry activities. This has placed at the disposal of management standards, or series of recommended practices, which have been formulated after full and careful consideration of scientific accuracy, practical application, and equity among all parties to all transactions.

Basic Assumptions

Those who have been active in this effort have had to make certain basic assumptions and have had to recognize certain practical limitations. For example, standardization in measuring, sampling, and testing—essential to the evaluation of crude oil and its products—must give consideration to solid, liquid, and even gaseous phases, each varying through wide ranges of composition and properties as related to handling and use.

Methods and procedures must be developed to produce satisfactory results when applied to oil and oil products which may not be homogeneous within a single shipment or container, and which may contain varying percentages of nonhydrocarbon substances. Such standards must take account of these variable ranges and characteristics, with the result that standards may be different for different cases or applications.

Although it is desirable to have world-wide common units of measurement and standardization of procedures, differences in values of commodities and special conditions at the various locations of measurements and tests must be recognized. Whenever values are low, costs of the measurements and tests themselves must be taken into account, with assurance of sufficient relative accuracy.

Whenever tests and measurements must be made afield, rather than under the more ideal conditions of the laboratory, methods and procedures must be rugged and practicable. Local customs have demanded and have received recognition. Individual managements have given support and encouragement to this program, with the result that methods and procedures have been greatly improved, and their application has been increased in efficiency and made more uniform.

New developments . . . The petroleum industry has always been a very dynamic business, and from all indications the future will be much more dynamic. There is an ever-changing list of petroleum and petroleum products, as well as the uses to which they are applied. It is essential that the measuring, sampling, and testing of these materials be kept abreast of all new requirements, and that established procedures be continuously reviewed with a view of their refinement and improvement.

What has been accomplished thus far is very good, and a lot of credit is due the technical staffs and the field personnel who are coping daily with this problem. These men have accomplished what appeared to be an impossible job many years ago. The tremendous effort which has been expended in order to make certain that fair and equitable treatment was given to all parties involved in the handling of the tremendous volumes from the well to the consumer can never be overlooked. Such an accomplishment is a credit to them and to the industry.

It is the industry's duty and responsibility continuously to follow new developments in order to make certain that, when they are available, the industry will be in a position to use them. Yes, oil men must ever help to develop and to assist the manufacturers of things such as electronic instruments and automatic measuring devices.

For many years oil men have recognized the hazards and risks taken by field personnel in climbing and gaging the tanks in all kinds of weather. Certainly anything which can be done to reduce this risk, and to protect the health and well-being of our employes, should not be overlooked. The petroleum industry is proud of its record in reduction of accidents of all kinds. In any development in the future, prime consideration should be given to improvement in the techniques which will reduce these hazards.

Special emphasis should be placed on the importance of timely and accurate figures. In the past, business—including the petroleum industry—was run somewhat haphazardly and without the aid of scientific management techniques. In recent years statistics and financial data have become more important in gaging the efficiency and the profitability of operations.

Statistics also have become very important in day-to-day decision making, and for this reason any delay in the gathering of the end results of measuring, sampling, and testing, and presenting them to management in a usable form, is a handicap to business and the industry. The pertinent data must be made available for decision making at the earliest possible moment.

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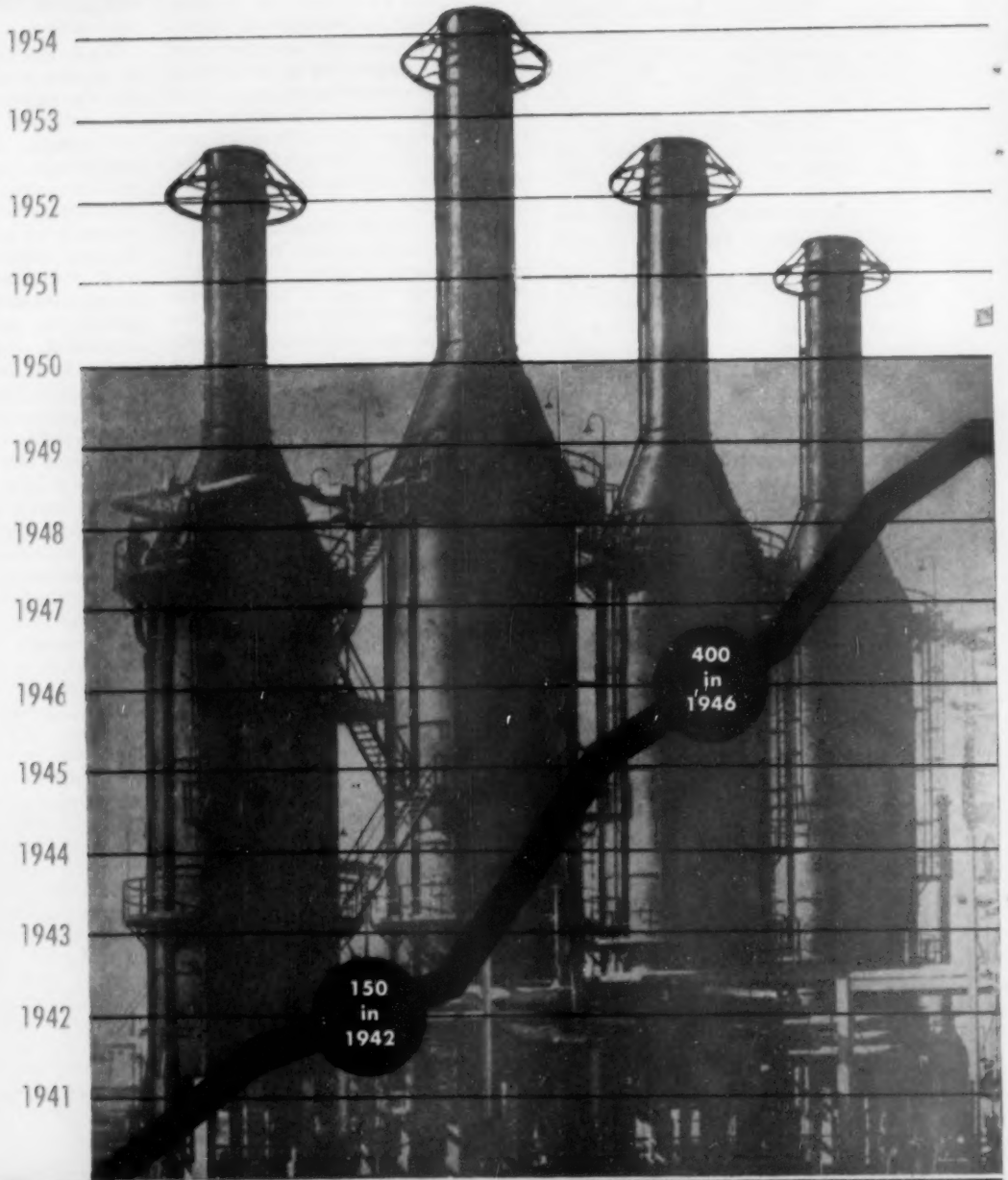

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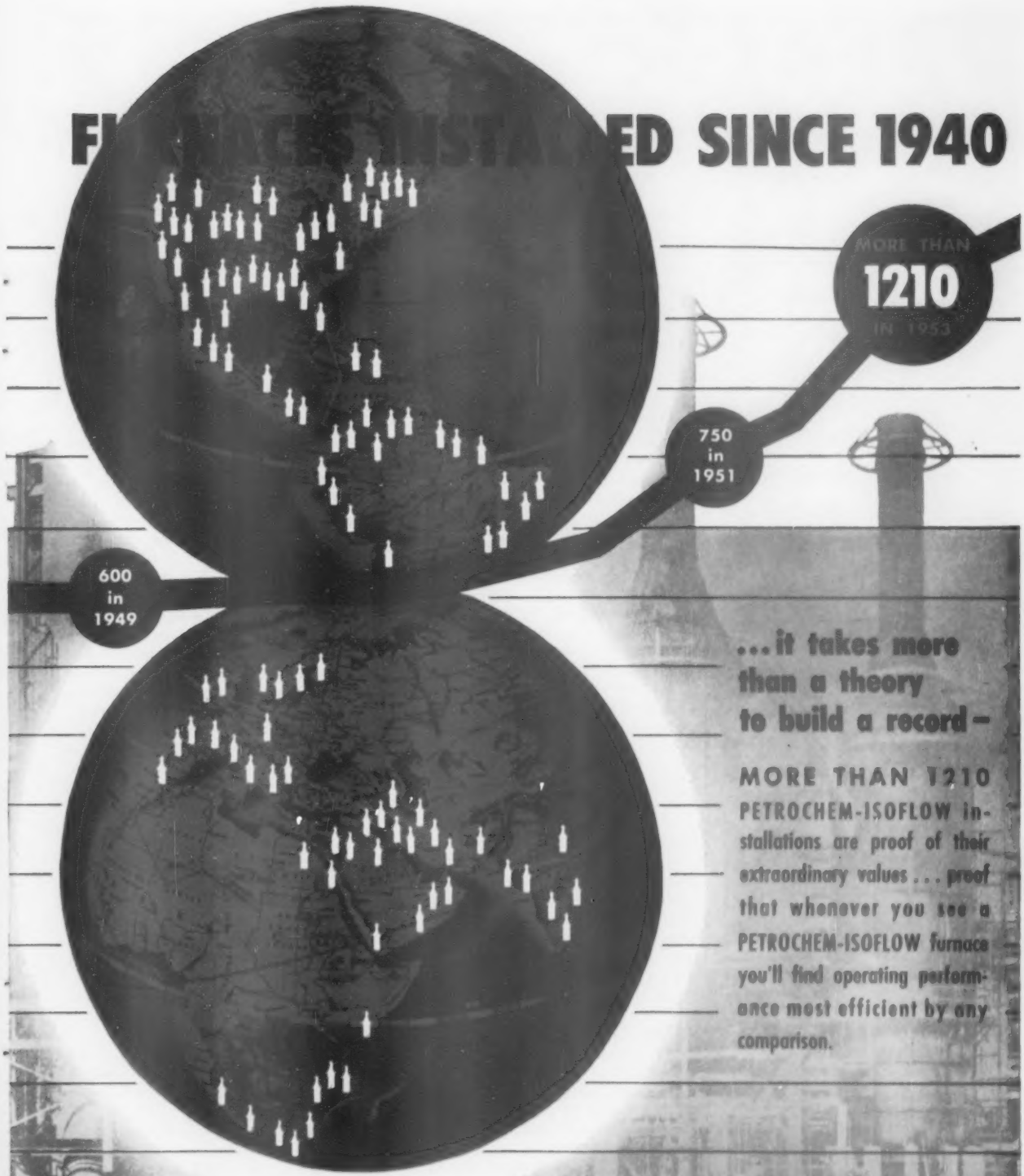

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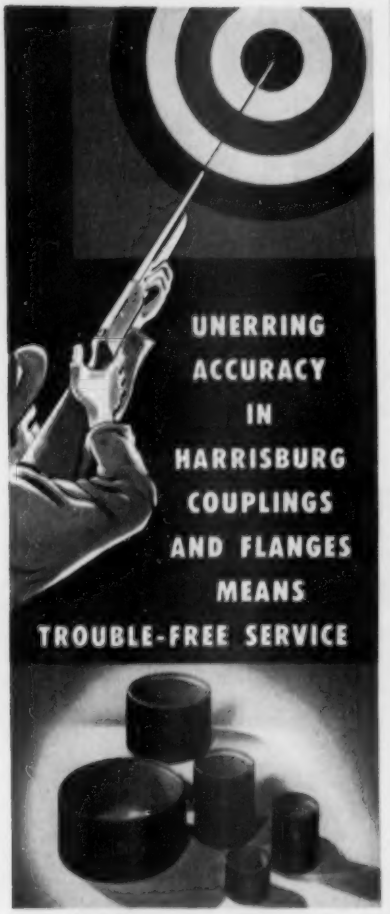

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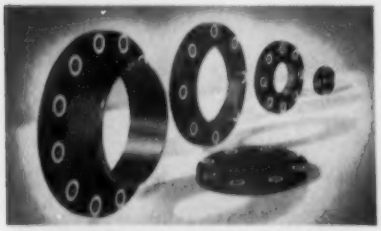

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A.P.I.—Oil Handling

Timeliness should be a prime consideration when making improvements in present procedures.

Of tremendous importance to the industry is the amount of shortage experienced in handling crude oil and petroleum products. Unless accurate measurements of all movements and storages are made available quickly, shortages and the cause of them cannot be traced. As you know, many companies have formed loss-control teams, and one of the major companies estimates its savings at approximately $1,000,000 for one year. With more prompt and accurate measurements the exact reasons for such shortages can be determined in time for corrective action.

Management is interested in the foregoing, and important improvements no doubt will be made in the future. Habits sometimes are hard to overcome, and there is no doubt that some habits have prevented the accomplishments and improvements which ideally are desirable. For example, recording can be "accurate," at least with respect to material of relatively low unit value, when measured in whole barrels.

The recording of measurements in fractional barrels in transactions involving large volumes of relatively low unit value seems hardly justified when one considers the time and effort expended. Under certain conditions consideration might very well be given to recording to the nearest whole barrel. This certainly would help to reduce the cost of paper work involved and should speed up the assembly of the data needed.

How does one accomplish all of these desirable improvements? It certainly is a tremendous job, and one which deserves the attention and support of management. It is not enough that management—including you people—knows about the situation, knows what is coming in the future, and knows what is expected. In addition to the formulation and adoption of proper standards, oil men need to train and educate the field personnel in the application of these standards. It is not enough to give them a thief and a tape and tell them to measure. It is not enough to tell them to read gages.

To accomplish a task of this magnitude the people need to be trained in the proper techniques which have been developed. They need to be informed about the importance of each and every measurement, sample, or test. It is very doubtful whether they each appreciate the relative importance of the measurements which they perform. It is doubtful whether they appreciate the importance of the quality of their performance in showing up the location and extent of the shortages which are being experienced by the industry. With this knowledge they could be expected to improve and to do a better job.

What has been accomplished is praiseworthy, but each of us needs to be alert to the importance of accomplishing more timely and more nearly accurate measuring, sampling, and testing of crude oil and petroleum products.

Conclusion

To summarize, management would like to have the over-all function of measuring, sampling, and testing crude oil and petroleum products accomplished with balanced consideration being given to the following ideals:

1. **Automatization:** Wide application of automatization should be encouraged. By such means, in many cases, many of the following summarized considerations will be accommodated.

2. **Personnel:** Qualifications of individuals selected to carry out these functions should be carefully prescribed, and specific training should be provided.

3. **Safety:** In choosing methods everyone involved should give special recognition to the hazards attached to these functions themselves, and also due regard to existing personnel and property risks of the industry so that these will not be increased by any requirement created by these operations.

4. **Short performance time:** To fulfill the need for prompt data so that timely decisions can be made, and to insure minimum delay in related operations of the industry, methods should produce rapid results.

5. **Simplicity and low cost:** Simplicity is desired to insure uniform application and ease in the training of operating personnel. Low cost is advantageous in overcoming the natural resistance to costly technical procedures.

6. **Scientific accuracy:** To the extent that results will be repetitively checkable, and will be acceptable to all parties to all transactions, accuracy is indispensable.

7. **Standardization:** The most complete standardization with a minimum of exceptions, deviations, permissible variations, and special restricted applications is most desirable.

8. **General acceptance:** Methods are to be hoped for which have all those characteristics which attract popular usage. In time, general acceptance in itself establishes, in effect, a standard which weaves itself into many business relationships and functions such as pricing, investment, tariffs, purchase, and sale.

What has taken place in the past is very good—but good is not enough. The job must be done better.

We can never eliminate all bends, but many authorities now claim that

Best Pipeline Is the Straightest One

. . . and it has been proved possible to lay pipe without any bends

by J. C. Stirling

WE can lay future pipelines with fewer bends than we now use or have used in the past. We can never eliminate all bends, but we can minimize them. Many authorities claim that the best pipeline is the straightest one, both horizontally and vertically.

Making fewer bends in the pipe will:

- Eliminate problems that arise from improper bending, ditching and laying.
- Promote the progress of construction.
- Keep the pressure drop to a minimum.
- Eliminate the straightening of reclaimed pipe.
- Reduce scrap.

Making fewer bends shifts more emphasis upon the preliminary processes of choosing the best possible right-of-way and of ditching to various depths. Cold smooth bending of pipe in the field, and then only as a last resort, is preferable to factory bends. But generally the best pipeline—and our aim is perfection—is the pipeline with the fewest pipe bends.

It is possible to lay pipelines without any bends and some are now bing laid to prove it.

Author is associated with Service Pipe Line Co., Tulsa. Paper presented at annual meeting, A.P.I. Chicago, November 9, 1954.

Detailed study . . . These conclusions have been reached after examining in detail published material on the subject, conducting numerous interviews, and receiving letters from about 25 experienced men in the field who represent as many different companies.

Facts and opinions came from all 18 members of our subcommittee and from half a dozen companies that manufacture pipe-bending equipment; other material came from specialists in the pipeline-construction business and from consultants.

Results of Survey

Results of the survey can best be presented in Question and Answer form.

Q. Is the elimination of all pipe bends advocated?

A. We can never reduce the normal number of weld fittings installed in the line at pump stations, nor can we eliminate bends in the pipe completely. But bends are used in many places where they are unnecessary. These we can certainly reduce.

Q. Does geographic location (topography) affect the number of bends?

A. Yes. Irregularities in the topography increase the number of bends required; the terrain of West Virginia, for example, is different from that of the prairie states. Surely no one believes that the Trans Mountain pipeline could have been laid without any bends. But why bend pipe unnecessarily?

Q. How do surveying and selecting a route affect pipe pending?

A. They are first considerations and therefore of prime importance. Good right-of-waying, before the ditching operation, takes care of many difficulties in terrain that cause abrupt overbends or sag bends in the line. This applies especially to the approaches to rivers, creeks, and draws.

It is possible to construct a pipeline over any given route just as a railroad or highway is constructed. It is perfectly logical that horizontal and vertical curves can be made by stressing the pipe safely within its limits of yield strength. It is physically possible, if not wholly practicable, to design and construct a pipeline free of all permanent bends in the pipe itself.

Q. How does ditching affect the number of pipe bends?

A. Most companies can eliminate all vertical bends by grading the ditch properly and allowing the pipe to conform by virtue of its inherent elasticity. Contractors can eliminate unnecessary bending by operating the ditching ma-

chine at various depths. Fitting the pipe to ordinary ground contour can be accomplished by grading, widening, and curving the ditch. Avoiding abrupt changes in alignment or grade reduces bends to a minimum.

Q. Is it possible to lay pipe without making any bends in it?

A. Yes. Seven miles of 6-in. pipe was laid in 1946 near Lindsay, Okla., over rolling terrain. The pipe weight was 17.02 and 14.97 lb. per foot. A few abrupt ravines were spanned, but in general the ditch followed the natural contour of the ground. Very little extra excavation was made to produce long vertical curves rather than abrupt angular deflections. In 8 years no trouble whatever has occurred from this line.

Across much of the Arabian desert there are no railrads, roadways, ditches, farm drain line, water courses, or other problems. Tapline constructed 450 miles of its 30 and 31-in. line in a beeline above the ground surface. Many of its sections are up to 5 miles long without even one bend in horizontal or vertical alignment. Steel in even high-carbon-content pipe in this line has proved that it can accommodate contraction or expansion through changes in temperature without any other provision for it.

A water line from Mulvane to El Dorado, in Kansas, has just been laid without any bending of the pipe. This line has 20 miles of 18-in. and 10 miles of 16-in. pipe with a wall thickness of 0.219 in. A few tube turns were used in places where it was impossible to force the pipe into the ditch. This line was laid along a railroad right-of-way that has several sharp curves; at one spot there is a deflection of about 60 ft. in 400 linear feet. The ditching machine merely stayed a certain distance from the right-of-way fence, making a "very pretty curve."

Q. What advantages are there in having no bends in the pipe?

A. 1. It eliminates the chance of improper bending by inexperienced crews or faulty equipment that cause the pipe to buckle or wrinkle.

2. It promotes the progress of construction because making bends is time consuming and costly. It relieves men and machinery for other construction work.

3. It helps to keep pressure drop to a minimum.

4. It eliminates the extra time, expense, and damage in straightening the pipe if it is later reclaimed, as on temporary lines.

5. It reduces the amount of scrap pipe.

Q. Is pipe bending expensive?

A. A bending machine costs about $15,000 plus rental of the shoe, which is not for sale. Rental is approximately ½ cent per foot. In addition to the bending machine, the process generally requires a tractor, a foreman, two operators, and five men—a total of seven or eight men at about $26 per man each day, plus insurance.

Q. Can bends be made too sharp or too steep? Why?

A. Yes, and the overbends often come out of the ditch because of excessive slack in the line. With no abrupt bends in the line, any movement can follow the curvature of the ditch. Pipe has a natural tendency to roll itself into and fit the ditch when the line does not have excessive overbends and sags. When the ditch is dug in long vertical curves instead of providing for sharp overbends, the tendency of the pipe to come out of the ground during the heat of the summer is eliminated—provided there is no excess slack.

Q. For approaches to crossings (railroad and highway), should we grade more deeply and use no bends or grade less deeply and use abrupt bends?

A. Eliminate bends if at all practical. If excessive ditching is involved, then of course we favor the bends. But there seems no good reason for putting bends in the line merely because of a road crossing. To be sure, circum-

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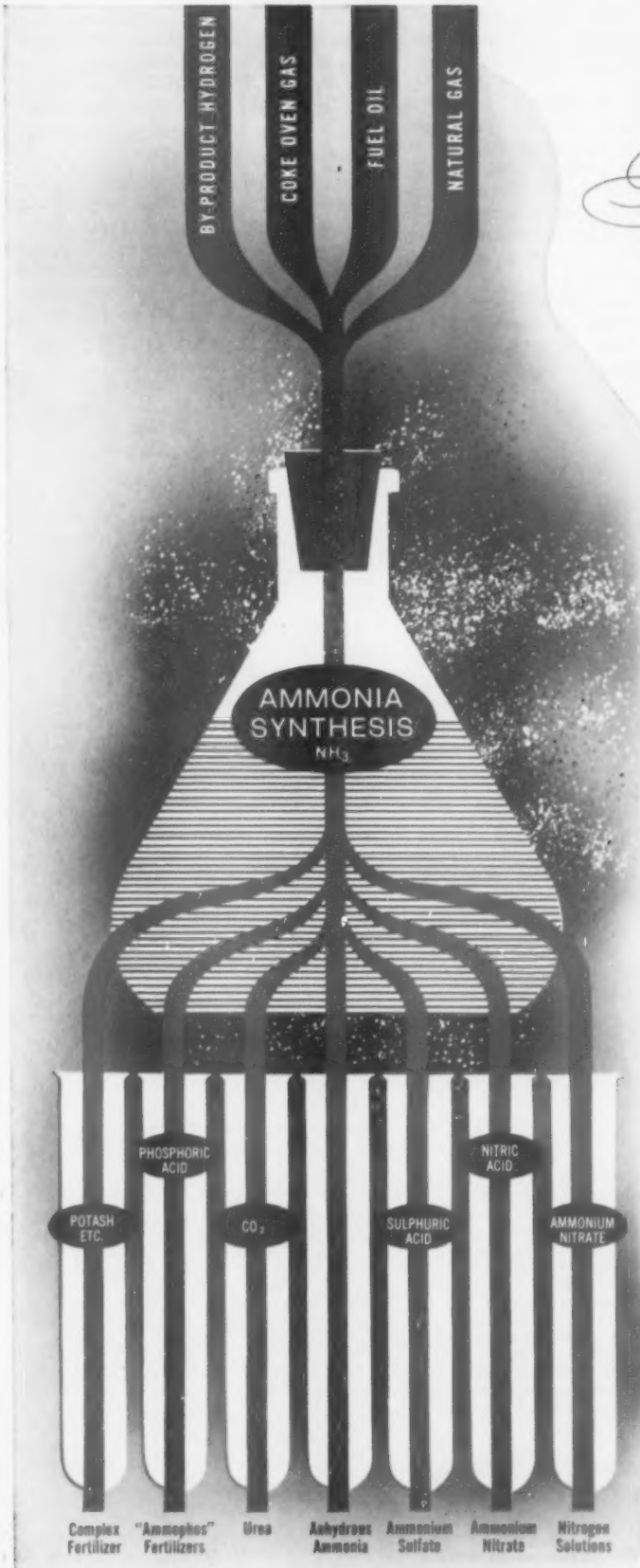

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stances alter cases, and the decision here becomes a matter of choice.

Q. What is the difference in cost of these two methods?

A. Ordinarily the contractor does not charge for bends, but he does for digging extra-deep ditches. Very few contracts call for extra payment for extra-deep ditches at crossings. Most companies are usually willing to trade a little deeper ditch for an extra bend. Right-of-way problems in developed areas often cause the making of horizontal bends; when this is the case, the companies set up specifications that will give free passage to scrapers, or go-devils.

A pipeline that requires considerably more grading naturally costs more money, and it may raise many objections from landowners. In some cases, building and other improvements might have to be moved, if bending the pipe to miss these obstacles were not allowed. River crossings are, of course, much more expensive.

Pipe bending can be reduced considerably through the choice of the route. Once a route has been established, bending pipe is less expensive than grading and ditching. The effect of bends on the performance of a pipeline is not sufficient to justify the added cost to eliminate the bends.

Q. Are factory bends advantageous, practical, and economical?

A. Since the present bending machines have been put on the market, factory bends have been practically eliminated on all crosscountry pipeline construction. Both fast and economical, modern bending equipment does not materially decrease pipe-wall thickness on the outside nor increase it on the inside.

Although factory bends are much better than the old fire bends or wrinkle bends, our present method is much more economical. Factory bends are not only expensive, but also require two circumference welds when they are installed. And some bends are usually left on hand. Few or no companies now use factory bends except in places where it is impossible to make a field bend.

Q. How about bends made on the job?

A. Bending pipe on the job is the common practice today. Cold bending with a modern bending machine or shoe, with the curvature distributed over a long section of pipe that includes no welds, is the most desirable structurally. Bends with a minimum radius of 50 ft. should suffer no measurable flattening, buckling, or weakening and should allow passage to the standard scraper. Pipe that buckles should be cut out and replaced at the contractor's expense.

Q. Are many unnecessary bends made on the job?

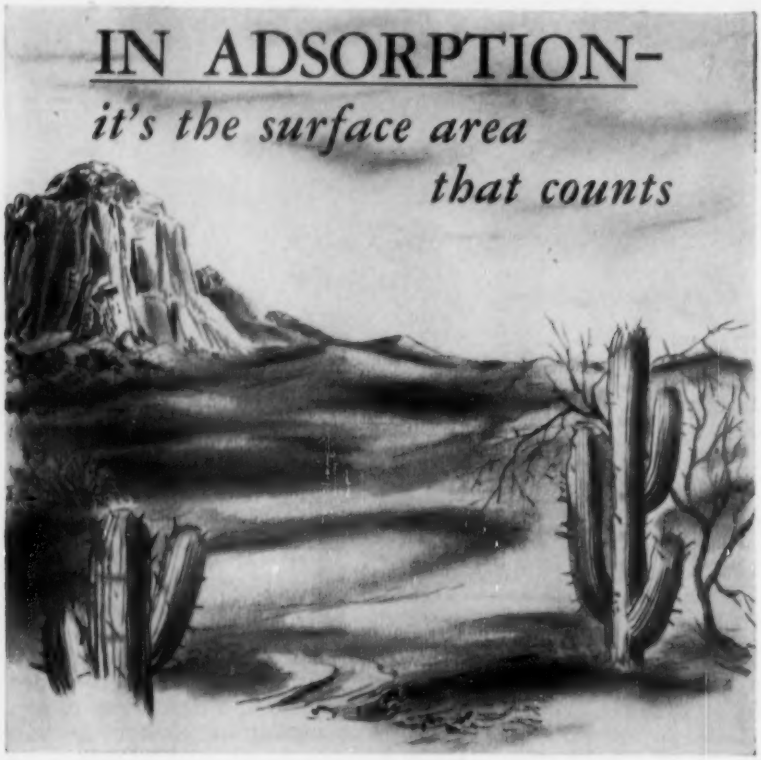
A. A line should be laid in the most direct route from the origin to the end by the quickest practical methods of sound construction. Since it is impractical to dig a ditch to grade for a pipe line, the next best thing is to form the line to follow the terrain of the right-of-way.

This can be done (1) by using weld angles or (2) by bending pipe. Where weld angles are used, it is necessary to make an additional weld and line up the joints to each end of the weld angle. When costs of weld angles, line-up time, and welding time are considered, this method is both time consuming and expensive. With hold smooth bending of 30-in. pipe it is not at all unusual for a bending crew to make over 100 bends a day.

Many unnecessary bends are made in the normal course of a line. In fact, over half of the bends now in pipelines are not necessary.

Q. Why is this true?

A. 1. The pipeline company's choice



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of route is not always the best. It is desirable to choose a route that traverses smooth terrain and is straight from one terminus to another.

2. Changes in alignment and grade can be taken care of by numerous bends that seem more economical.

3. Habit or custom has decreed that we must make so many bends to prove that we're skillful pipeliners.

Q. Where are bends absolutely necessary?

A. When landowners are unwilling to grant a right-of-way for a line obstructing their property, there may be no alternative. Bending pipe is preferable to adverse public relations. In congested areas or areas of difficult terrain, even additional ditching may not obviate both horizontal and vertical bends. But bends in the pipe should be used only as a last resort.

Q. Which is more easily repaired—a break in a bend, or a break in a straight line?

A. A failure in a bend is definitely more difficult to repair than a break in a straight line. On the other hand, pipeline without any bends can be pulled into the ditch so that the pipe is laid in a strain. Sometimes it might even be impossible to place a welding sleeve or leak clamp on the line because of the curvature of the pipe. Then if the pipe would break in two, it would be impossible to get a good lineup to make repairs without stripping several hundred feet of pipe in each direction.

Q. Is pipe weakened or strengthened by bending?

A. Some authorities have proved that bending causes no detrimental change in the physical properties of pipe. They claim that bending increases the yield strength materially, although it slightly decreases the ductility of the pipe. Without the modern bending machines, the pipe might be weakened and even more so if it were reclaimed and straightened.

One school of thought contends that bends made during construction present a negligible pressure drop; another school of thought theorizes that bends offer expansion and contraction points for line pipe in cases of surge and thermal movement.

Bending methods have improved notably by the use of segmented bending shoes on tractors for smaller diameters of pipe and by the use of powered, calibrated bending machines for larger diameters. Smoother bends are now achieved with negligible flattening.

Q. What are the generally recognized types of bends?

A. (1) Slight bends; (2) bends beyond the yield strength of the steel but within limits generally considered to be safe—not injurious to the steel; and (3) bends of such short radius that some type of tube-turn fittings should be welded into the line no effort made to bend the pipe itself.

Safe limitations for any pipe bend can be computed mathematically.

Q. Do bends cause any costly, troublesome, or hazardous problems?

A. Bends always present engineering problems. If a pipeline is laid on top of the ground, the problems of anchorage, expansion, and temperature stress become highly important and cannot be left to chance. Offset bends that are unable to transmit appreciable end thrust must not be installed unless sufficiently flexible to absorb the maximum necessary movement. All above-ground bends, either vertical or horizontal, require anchorage.

In general, no bend should be used if its cross-section is deformed from circular so that any diameter differs more than 5 per cent from the original diameter. The minimum radius of curvature should be 20 times the actual outside diameter of the pipe. Pipe-wall thickness should not be reduced more than 5 per cent in the bending process. No wrinkle bends are permitted, and mitering is no longer recognized as a generally accepted means of making changes in direction.

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. . . provided these principles of know-how are applied

The Author Says:

Radiographic inspection was used on a total of 47,884 miles of pipeline construction from 1945 through 1953. With this wide usage it behooves pipeline engineers to pay particular attention to these points:

• Choice of radiographic sources and methods is most important. Selection should be based on maximum permissible voltages for thickness of metal to be examined. X-ray is indicated as the choice for most pipeline work.

• Radiographic inspection should be used to effect rigid control of welds. A properly made and interpreted radiograph not only enables the determination of number and types of defects, but also any trend of the welder to drift away from correct procedure.

• Standardized qualification tests should be instituted for radiographers. The operator should have basic understanding of the radiation source; test exposures should be checked by an inspector; operator's procedure should be checked for radiation safety; and operator should demonstrate proof of knowledge of pipeline welding procedures.

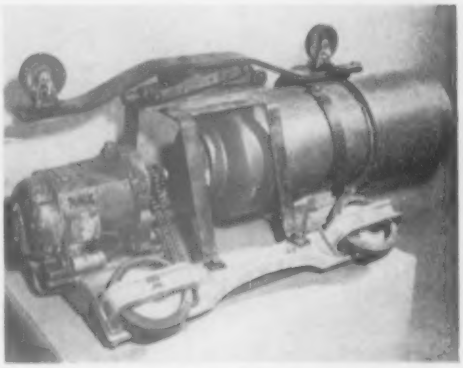

Fig. 1—X-ray unit mounted on conduit tractor.

by Harold Hovland

THE A.P.I.-A.G.A. Joint Committee on Oil and Gas Pipe Line Field Welding Practices has made exhaustive studies on current pipeline-welding practices. Its radiographic subcommittee recently conducted a survey to determine the extent of the use of radiography for pipeline-weld inspection.

This survey indicated that radiographic inspection was used on only 82 miles of pipeline construction in 1945 and on 12,515 miles in 1953. As of the end of 1953 radiography has been used on a total of 47,884 miles of pipeline construction. Of this total, 16,199 miles was petroleum and petroleum-products lines, and 31,685 miles was gas pipelines.

From this it is evident that radiographic inspection of pipeline welding has met with wide and general acceptance in pipeline construction. We now have sufficient experience with its use to formulate definite observations regarding its effectiveness as an inspection method and as a means of controlling weld quality on pipeline construction.

In other industries it has been found that radiography will lower costs and speed production. Designers accustomed to using heavier plate as a safety factor have found that by the use of radiography they can control the fabrication and can assure soundness with lighter-weight materials. If used properly there is no doubt that radiography can accomplish the same thing in pipeline construction.

Author is associated with Industrial X-ray Engineers, Seattle. Paper presented at annual A.P.I. meeting, Chicago, November 9, 1954.

Advantages . . . Obviously there must be considerable merit to an inspection method which has been so widely accepted by the industry. These are the factors which attract pipeline engineers to this method of inspection:

1. It assures a uniformly higher-quality welded joint because it provides inspection with "eyes" to see below the surface and to examine the inner weld structure.

2. Unless the weld is defective it is not removed from the line. This means a real saving in line construction time, as well as in cost to the owner. Many radiographic inspections may be made for the cost of one weld removed. Only the unsound welds are removed or repaired.

3. Radiographic inspection properly used provides the means to control weld quality of those welds not inspected. This means less likelihood of failures and leaks on tests and in subsequent service of the line.

4. The owner is provided with a graphic record of the quality of the field weld, as well as much information on the pipe itself.

Proper Sources

The Welding Handbook of the American Welding Society devotes an excellent section to weld radiography. On page 976 the handbook states: "the low contrast levels obtainable for gamma rays render them unsuitable for most weld inspection." This is so because of the nature of the extremely short penetrating rays obtained from most gamma-ray sources, or at least from those which are presently available for weld inspection.

On page 10, paragraph 1.721 of A.P.I. Std. 1104: Standard for Field Welding of Pipe Lines there is given a table of maximum X-ray voltages for steel thicknesses to be examined. It is reproduced herein as Table I.

Paragraph 1.724 on page 11 of the same publication gives the voltage equivalents of the presently available radioisotopes. Because in most pipeline work we deal with wall thicknesses of 0.22 to 0.50 in., reference to these

TABLE I

Maximum X-Ray Voltages for Steel Thicknesses to be Examined (from A.P.I. Std. 1104)

Total Parent-Metal Thickness (in.)	Maximum X-Ray Voltage (kv.)
1/4 and under	110
9/32 to 3/8, incluive	130
13/32 to 5/8, inclusive	160
21/32 to 7/8, inclusive	200
29/32 to 1 1/2, inclusive	300

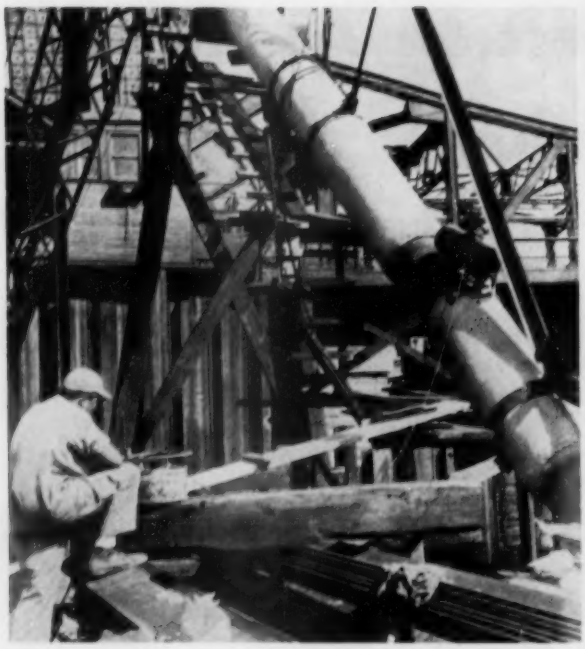

Fig. 2—Radiographing tie-in weld with X-ray unit outside the pipe.

Fig. 4—Placing X-ray inside river-crossing pipe.

tables will show why X-ray is indicated as the choice radiographic source on most pipeline work.

Table 2 shows these data. If, for instance, one wished to radiograph a pipe wall of a thickness of 9/32 to ⅜ in., reference to Table 1 would indicate 130 kv. as the maximum kilovoltage to be used. When Table 2 is referred to, it is evident that the use of cobalt 60, which has a 1,200-kv. equivalent, is 10 times more penetrating than the maximum which should be used.

The use of cobalt 60 on wall thicknesses of this order results in the production of radiographs of low contrast, which lack the ability to reveal fine defects such as cracks. Such a radiograph is worse than none at all because it is misleading. If an isotope source were to be used, Table 2 indicates iridium 192 would produce the best results of the isotopes available because its kilovoltage equivalent is closer to the proper value indicated.

Sensitivity . . . The term "radiographic sensitivity" refers to the ability of a given technique to reveal discontinuities or change in density present in the material being examined.

The most serious defects we have to cope with in pipeline welding are cracks. This is particularly true with A.P.I. Std. 5LX pipe or other grades in that class. For this reason it is necessary that the radiographic method used have the highest possible "radiographic sensitivity." This should be 2 per cent or better.

Therefore, we believe X-ray, with which the radiation wave length available can be correctly adjusted to the thickness of steel to be radiographed, is the radiographic source of choice. It has the further advantage of greater radiographic speed which makes the examination more versatile and which enables it to be used with special situations occurring in pipeline construction.

TABLE 2

Kilovoltage Equivalents for Radioactive Sources (from A.P.I. Std. 1104)

	Voltage (kv.)	Thickness of Lead * (in.)
X-ray	150 and over	0.005
Iridium 192	200 to 600	0.005
Cobalt 60	1,200	0.020
Radium	800 to 2,300	0.005 to 0.020

*The values given here are recommended lead screen thicknesses to be used with each source.

Weld Inspection and Control

Let us distinguish between weld inspection and welding control. A given weld may be inspected any time after it has been made. If the inspection does not closely follow the fabrication, the information gained from the inspection is of no value for the control of intervening weld quality. Therefore,

A.P.I.—Pipelining

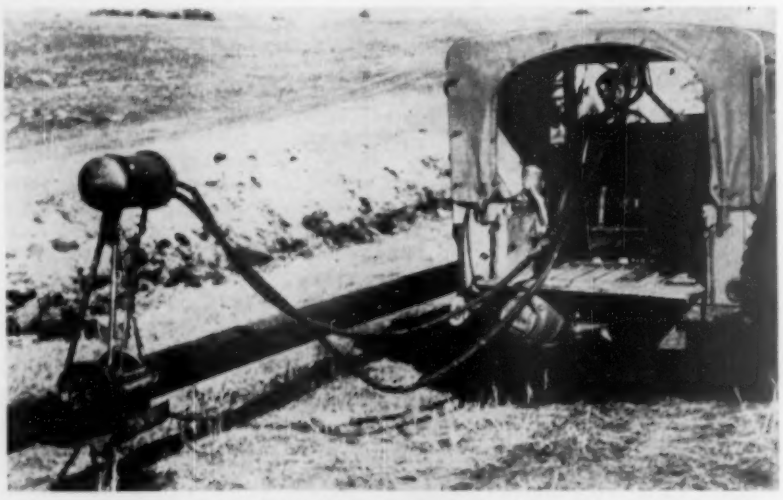

Fig. 3—Radiographing small-diameter-pipe weld.

the inspection is like a "go or no go" gage.

Physical tests, because they expose such an infinitesimal portion of the weld, are of little value for weld control. Therefore, the correct way to use radiographic inspection is immediately behind the welding crew, and the flow of information between the X-ray crew and the welding crew should be made constant and current.

Pipeline construction is loaded with the human element. Human beings change psychologically and physically from one day to the next. It is as important to have a constant and continuing check on a welder's production from day to day as it is to qualify him originally. Also experience shows that more than 50 per cent of all defects in field welds are caused by members of the construction crew other than welders.

Procedural errors caused by improper spacing, improper lineup, movement of the pipe, out-of-round pipe, variations in inside diameter, temperature changes, and changes in the chemical content of the steel are matters which the welder cannot always control.

Quality control . . . To effectively control the quality of welding, test methods are required which will give maximum information. A properly made and interpreted radiograph of the weld has the advantage of allowing one to see not just a cross-section but a continuous area. From it we can determine not only the number and type of defects but any trend or tendency of the welder to drift away from correct procedure.

In weld control it is important to detect such trends before they result in unacceptable welding. For instance, a welder frequently will become careless in cleaning slag, unintentionally change the length of his arc, or fail to adjust his machine setting correctly. Originally such carelessness or error may not cause unacceptable welding, but experience shows that, if continued, defects caused thereby usually become more frequent and exaggerated.

If not corrected they ultimately result in cutouts or repairs. The trend on a radiograph is a red flag to the radiographer. As soon as one is indicated, successive radiographs of the particular welder's work are examined carefully to determine if the error is continuing and, if so, to call it to the inspector's attention immediately.

Statistical sampling . . . Much has been written on statistical sampling. There is a great difference in the results of the statistical sampling of an automatic manufacturing process, as compared to a project requiring hand welding. For example, in the manufacture of machine screws it has been proved that statistical sampling of a fraction of 1 per cent is for all practical purposes as effective as if each item had been examined individually. But in the case of hand welding on field construction jobs we find the quality of the product entirely dependent upon the vagaries of the human element—not only of the welders but of all the crafts which contribute to the fabricated product.

To this we must add the important factors of weather and construction mechanical problems. For this reason we believe that the quality of the welding is in direct proportion to the percentage of the work tested.

Most pipeline radiography is primarily quality-control radiography or percentage sampling.* Originally, because of equivalent limitations, we were fortunate if we could examine 10 per cent of the welds in 1 day, plus 100 per cent of the welding on river crossings. As the percentage of welds examined is increased, higher weld quality is attained. Technological improvement in equipment and methods today permits 30 per cent coverage of welding for lower total costs than with 10 per cent coverage in 1946.

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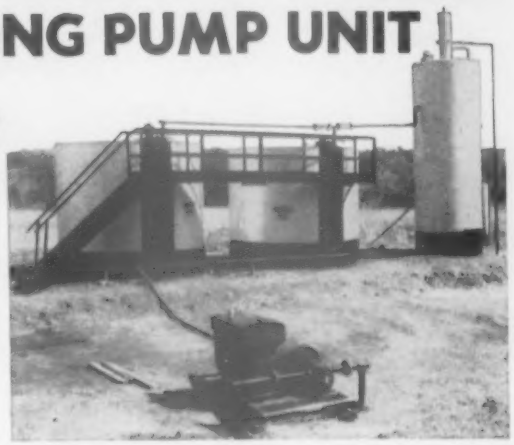

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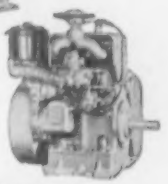

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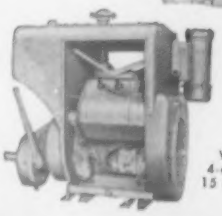

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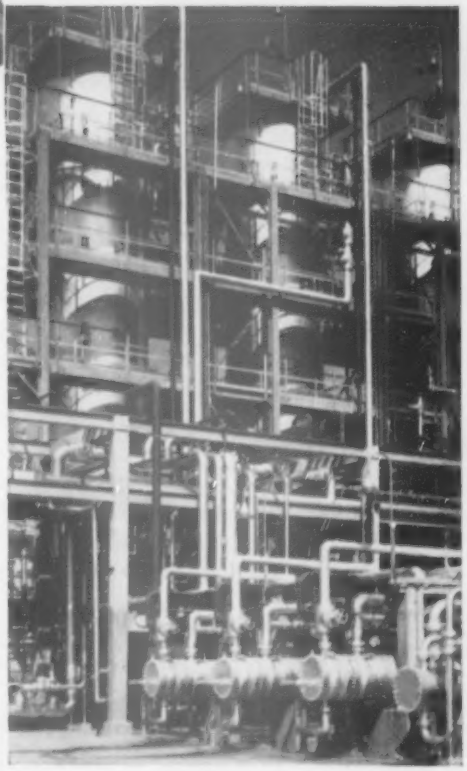

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A.P.I.—Pipelining

It should be pointed out that many radiographic techniques allow for the examination of only a portion of a circumferential weld in one exposure. This should be considered when the percentage of the examined welding is being determined.

First use . . . The first petroleum pipeline radiography was done in 1946. We used radium as our radiographic source, inasmuch as there was no equipment portable or rugged enough for pipeline use. We always have preferred to have the radiographic source inside the pipe whenever possible because then it is only necessary to penetrate one wall of the pipe, and better radiographic sensitivity is attained.

To place the gamma-ray source inside the pipe it was necessary to drill a hole near the weld. Considerable objection developed to the problems of the hole and the resultant repair which was required. Today most gamma-ray techniques use the source outside the pipe. With this technique three to four radiographs are necessary to examine one complete weld. The allowable and useful coverage for any given size of pipe, with the source outside, is specified in A.P.I. Std. 1104, page 11, Table 1.

In 1947, extremely portable X-ray equipment—together with a conduit tractor which propels the X-ray through the pipe—was developed. This permits a single-thickness complete weld coverage in one exposure. With this technique a radiographic sensitivity of approximately 1 per cent can be attained. This equipment will operate in 16-in.-diameter pipe and larger. Fig. 1 illustrates a conduit tractor and X-ray unit. On river crossings or with double-jointing procedures this equipment can be used on pipe diameters as small as 12 in.

However, it still is necessary to radiograph tie-in welds and most pumping-station welds from the outside. These weld examinations, whether X-ray or gamma-ray, should be made in accordance with A.P.I. Std. 1104, page 11, Table 1. Fig. 2 illustrates a tie-in weld being examined with the X-ray source on the outside of the pipe.

Pipeline welds less than 16 in. in diameter usually are radiographed from the outside. Pipeline welds 10 in. and smaller are radiographed in elliptical projection. This provides complete weld coverage in two exposures taken at 90°. This is illustrated by Fig. 3.

Pipe welds on river crossings are radiographed 100 per cent. Offsetting the cost of radiography is the fact that rarely are welding sleeves used where 100 per cent weld radiography is employed. Usually on barge work the radiographic source is kept inside the pipe and is controlled by a cable through the line-up clamp.

As each weld is completed, it is radiographed and the film is processed while the joint is being coated. Thus, if the weld is acceptable, the only delay for the crew is the 2 to 5 minutes required for the X-ray exposure. Fig. 4 illustrates this procedure.

Operator Qualifications

If the radiographic method is to be successful in attaining good inspection in the control of weld quality, it is necessary to have qualified and competent radiographic operators. Much pipeline radiography has been performed by personnel not qualified for the job by either experience or training.

Pipeline owners should employ standardized qualification tests for each radiographic operator, just as they do for their pipeline welders. Such tests should include the following:

1. There should be proof that the operator has a basic understanding of the radiation with which he is working.
2. Actual test exposures should be made in the exact manner which is

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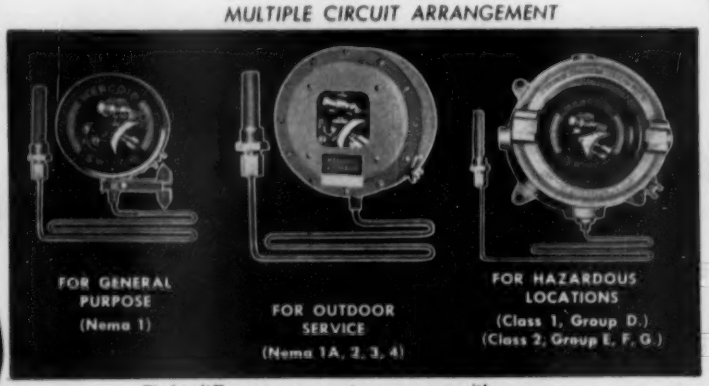

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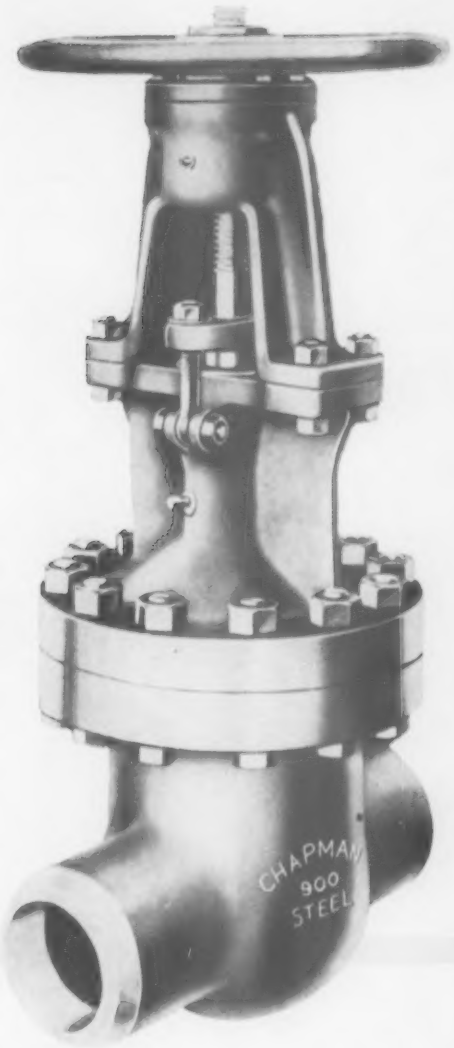

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proposed for line-weld radiographs and on weld coupons similar to the line pipe. The test radiographs should be checked carefully by the inspector against the line-weld radiographs to make sure that radiographic quality is maintained.

3. The operator's procedure should be checked for radiation safety. Radiographic operators should be required to wear radiation badges monitored by a recognized testing laboratory.

4. There should be proof that the operator has experience and knowledge of pipeline welding procedures.

With the widespread use of radiographic inspection on pipeline work it is important that owners not only obtain the proper type of radiography, but also that the radiographic personnel be qualified in their duties to the end that other workers and the public are protected from radiation hazards.

Radiographic Costs

In discussing radiographic costs it is understood that, all other factors remaining the same, they will vary according to geographic location and weather conditions of the job. Most radiographic contractors work on a daily basic fee, plus so much per radiograph or weld examined.

In 1948 a 10-in. petroleum line costing $23,650 per mile had 9.35 per cent of the welds radiographically examined for $122.22 per mile, or 0.023 cent per foot of right-of-way. The cost per weld examined was $8.30. Radiographic inspection represented 0.5 per cent of the line cost.

In 1949 and 1950 an 8-in. products line cost $17,569 per mile for construction. A gamma-ray source was employed for radiographic inspection with the source being outside the pipe. From 25 to 30 per cent of each weld was radiographically examined; 9.75 per cent of the welds were so examined at a cost of $70.12 per mile.

The cost per radiograph representing one-third of the weld was $9.30. The cost per foot of right-of-way was 0.013 cent. In 1950, 10 per cent of all welds on a 10-in. products line were completely examined at a cost of 0.02 cent per foot of right-of-way, or $9.15 per complete weld examined. In 1950 it was necessary to use the outside-exposure technique on lines 20 in. and smaller. A 20-in. petroleum line was so examined at a cost of $4.38 for one-third weld exposure.

Many improvements . . . Improvements in technique and equipment have made possible a greatly increased percentage of radiographic tests for the same amount of dollars. For example, today the X-ray with conduit tractor can be used on pipe diameters of 16 in. and larger. Generally speaking, the cost per foot of right-of-way for X-raying 10 per cent of the welds is 0.0189 cent. For 20 per cent it is 0.0284 cent. For 30 per cent coverage it is 0.0331 cent. These estimates are based on the average construction rate of about 1 mile per day. When radiographic inspection is considered, it is management's problem to determine whether 10, 20, or 30 per cent inspection is desired. Naturally this point will be influenced by pipe size and by engineering and safety considerations. It is the writer's considered opinion that on larger-diameter lines 30 per cent weld inspection is the best buy for the owner.

A radiographic contractor has a basic fixed cost of operation in any one operation. Therefore, it is obvious that the fewer the welds examined the higher will be the cost per weld. From experience we know that the owner buys a much better pipeline for very little in additional dollars when a greater percentage of the welds is examined.

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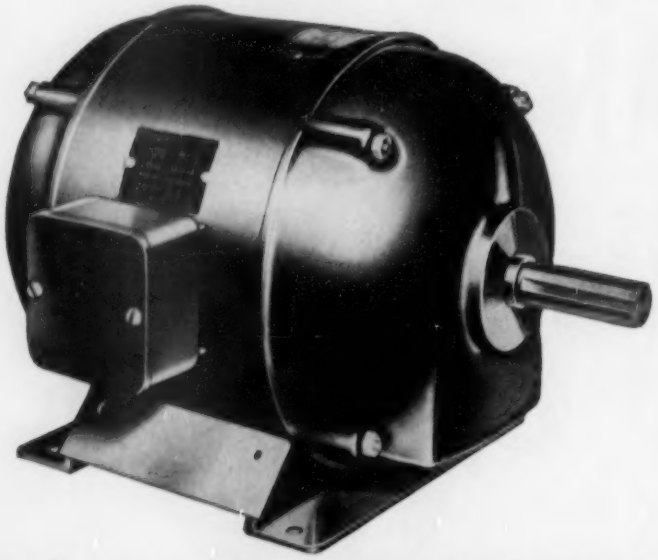
1. Welding Handbook, 3rd Edn., 970-90, American Welding Socy., New York (1950).

2. A.P.I. Std. 1104: Standard for Field Welding of Pipelines, 2nd Edn., A.P.I., Washington, D. C., Feb. (1954).



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These results have been obtained during studies by the subcommittee on pipeline hydraulics, Division of Transportation, American Petroleum Institute.

Fifteen companies, operating large-diameter lines in 12 states, participated in the program and submitted test data. Fifty-eight flow conditions were obtained in 36 sections of pipeline varying in diameter from 12 to 31 in. Data obtained from actual operations showed Reynolds numbers of 40,000 to 250,000.

Location . . . The geographical distribution of the lines tested is widespread. Twelve states (Louisiana, Mississippi, Texas, Oklahoma, California, Maine, Georgia, Kansas, Missouri, Illinois, Indiana, and Iowa) and two foreign countries (Canada and Saudi Arabia) are represented. Lines, when tested, had been in service from 3 weeks to 14 years, and are used to transport from one to six grades of crude oil.

Pipe . . . Diameters of the crude-oil pipelines ranged from 12 to 31 in. Test conditions were reported on one 12-in., three 16-in., six 18-in., thirteen 20-in., seven 22-in., seven 24-in., four 26-in., and one 31-in. lines.

The lengths of sections tested varied from 7 to 176 miles. Most section lengths were between 38 and 110 miles.

Most of the pipe was electric welded.

Author is associated with Service Pipe Line Co., Tulsa. Paper presented at annual meeting, A.P.I., Chicago, November 9, 1954.

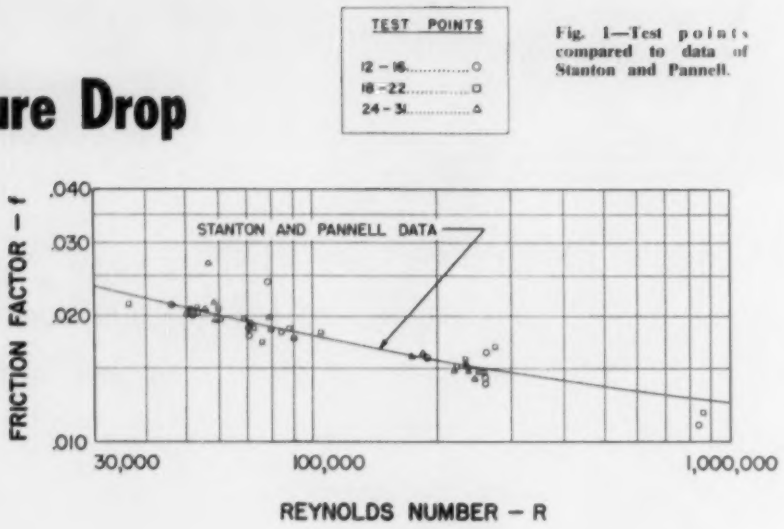

Fig. 1—Test points compared to data of Stanton and Pannell.

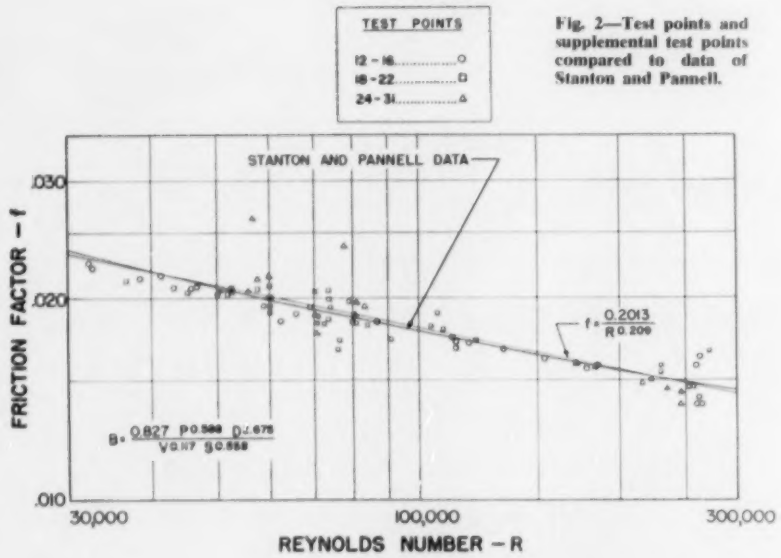

Fig. 2—Test points and supplemental test points compared to data of Stanton and Pannell.

B = line throughput, bbl./hr.
P = pressure drop, psi./mile
D = i.d., in.
V = kinematic visc., cs.
S = sp. gr. of liquid pumped

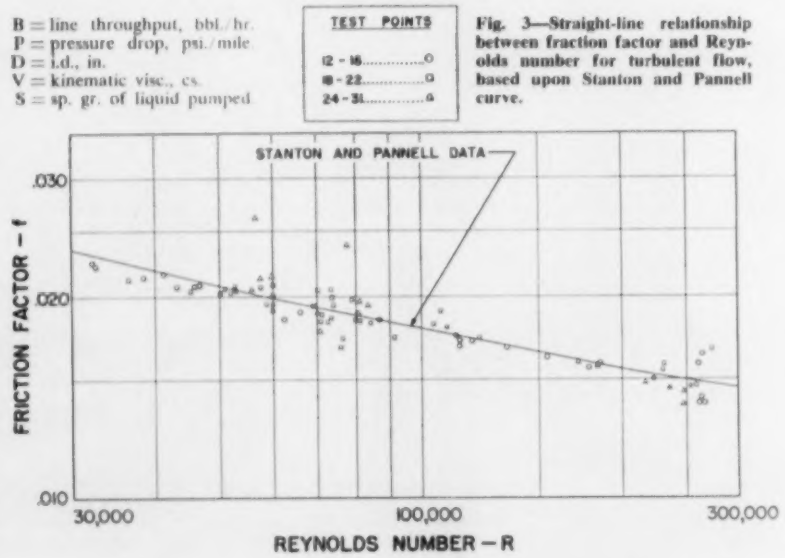

Fig. 3—Straight-line relationship between fraction factor and Reynolds number for turbulent flow, based upon Stanton and Pannell curve.

WHEATLAND STEEL PIPE

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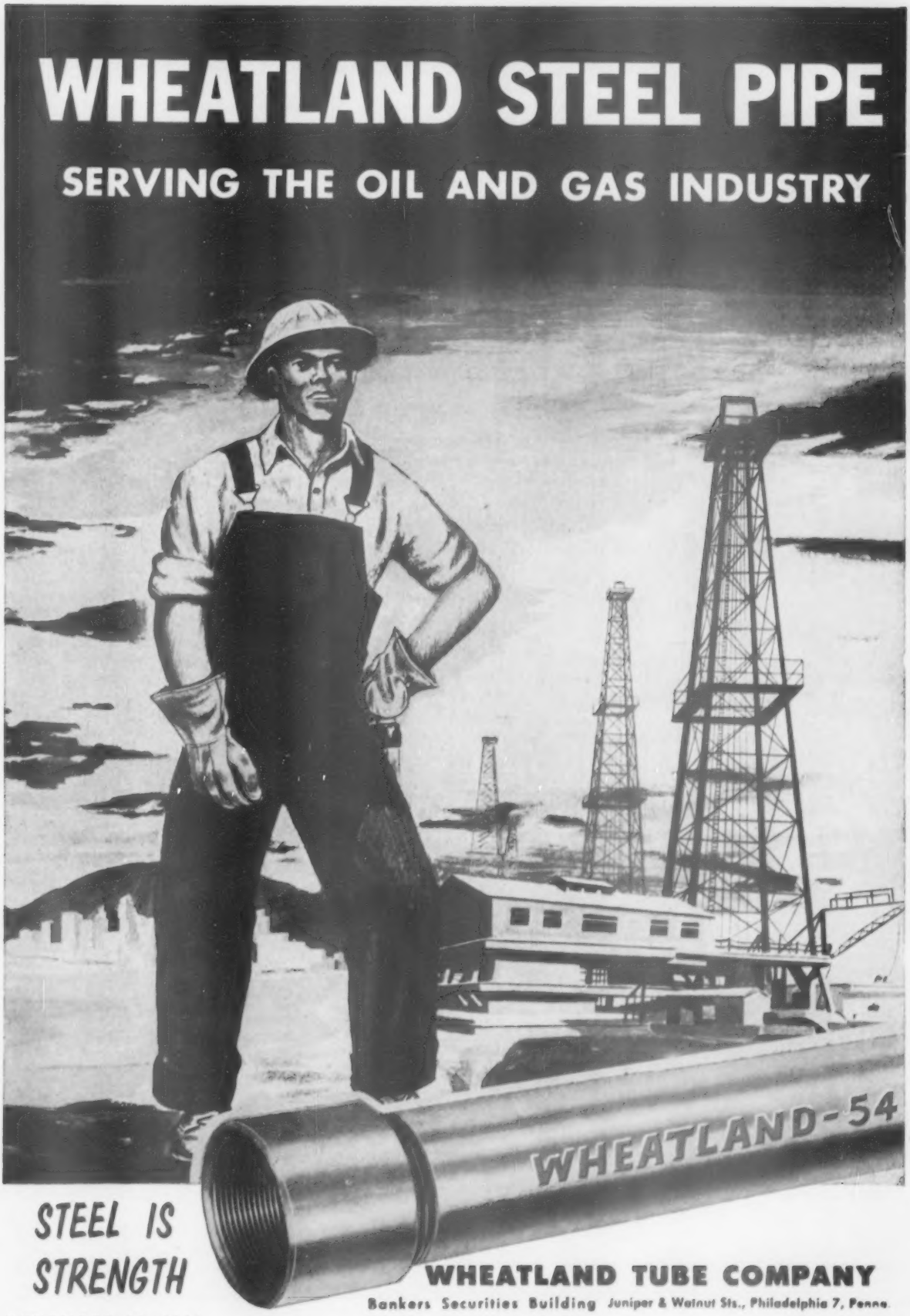

STEEL IS STRENGTH

WHEATLAND TUBE COMPANY

Bankers Securities Building Juniper & Walnut Sts., Philadelphia 7, Penna.

TABLE I—GENERAL INFORMATION AND RESULTS OF TESTS

Company and location of line—	Crude in line	Date of test	Date last scraper run	Years line in service	Eq. length in miles and size	Rate of flow, bbl./hour	Calculated— Reynolds number "R"	Calculated— Friction factor "F"
Mid-Valley Pipe Line Co.:								
Louisiana and Mississippi	West Texas	2-15-53	2-13-53	2.50	54.6—20-in.	8,217	223,794	0.01518
West Texas Gulf Pipe Line Co.:								
Texas	West Texas	7-13-53	7- 6-53	0.50	67.2—26-in.	13,108	247,017	0.01424
Texas	West Texas	7-13-53	7- 6-53	0.50	67.2—26-in.	12,568	236,841	0.01467
Texas	West Texas	7-13-53	7- 6-53	0.50	67.2—26-in.	11,656	219,655	0.01492
Pan American Pipe Line Co.:								
Texas	West Texas	10- 2-53	2- -53	0.75	7.4—26-in.	7,595	185,954	0.01605
Trans-Arabian Pipe Line Co.:								
Saudi Arabia	Arabian	6(13-19)53	Not run	2.50	201.3—31-in.	13,765	174,000	0.01610
Service Pipe Line Co.:								
Oklahoma	West Texas	7-15-53	5-15-53	2-7	70.7—20-in.	6,376	258,200	0.01473
Oklahoma	West Texas	7-22-53	7-15-53	2-7	70.7—20-in.	6,250	253,100	0.01472
Oklahoma	West Texas	10-14-53	7-15-53	2-7	70.7—20-in.	6,040	230,790	0.01541
Interprovincial Pipe Line Co.:								
Canada	Redwater	5(15-19)53	5- 7-53	3.00	109.9—20-in.	6,520	51,330	0.02055
Canada	Redwater	5(15-19)53	5- 7-53	3.00	109.8—20-in.	6,686	52,110	0.02020
Canada	Redwater	5(15-19)53	5- 7-53	3.00	116.9—20-in.	6,588	53,200	0.02070
Canada	Redwater	5(15-19)53	5- 7-53	3.00	103.9—20-in.	6,520	53,080	0.02040
Standard Oil Co.—California:								
California	San Joaquin	5- 2-53	4-15-53	8.00	77.7—18-in.	4,633	68,800	0.01960
Magnolia Pipe Line Co.:								
Texas	M.C.	12- 1-53	11-24-53	0.10	155.0—16-in.	2,171	46,819	0.02087
Texas	W.T.-M.C.	11-16-53	11-10-53	5.00	83.4—20-in.	4,868	90,904	0.01753
Texas	W.T.	11-16-53	11-10-53	5.00	83.4—20-in.	4,551	84,455	0.01834
Portland Pipe Line Co.:								
Maine	W. Tarra	1- 5-53	12-31-52	3.00	39.4—18-in.	5,436	70,958	0.01919
Maine	Hy. Ofic.	7- 2-53	6-17-53	3.00	39.4—18-in.	5,485	59,243	0.01956
Maine	Oficina	7-25-53	6-17-53	3.00	39.4—18-in.	5,457	80,322	0.01859
Humble Pipe Line Co.:								
Texas	Hawkins	12- 3-53	None	0.67	21.8—16-in.	2,140	4,462	0.03677
Texas	Hawkins	12- 4-53	None	0.67	21.8—16-in.	3,219	5,896	0.03600
Texas	West Texas	12- 1-53	9- 1-53	3.50	78.9—18-in.	2,846	36,887	0.02136
Texas	West Texas	12- 1-53	9- 1-53	3.50	78.9—18-in.	3,504	50,386	0.02033
Texas	West Texas	4-19-48	1- 1-48	0.33	39.4—20-in.	4,752	232,646	0.01591
Texas	Panhandle	4-22-48	1- 1-48	0.33	39.4—20-in.	7,075	105,111	0.01831
Texas	South Texas	4-23-48	1- 1-48	0.33	39.4—20-in.	7,000	274,030	0.01678
Sinclair Pipe Line Co.:								
Missouri	M.C. & Wyo.	7-21-53	7-17-53	0.50	32.4—22-in.	4,990	76,796	0.01730
Missouri	M.C. & Wyo.	7-22-53	7-17-53	0.50	88.9—22-in.	5,026	73,498	0.01860
Illinois	M.C. & Wyo.	7-22-53	7-20-53	0.50	33.6—22-in.	5,131	71,259	0.01870
Illinois	M.C. & Wyo.	7-27-53	7-23-53	0.50	162.1—22-in.	5,793	80,312	0.01870
Illinois	M.C. & Wyo.	7-24-53	6-19-53	0.50	21.7—22-in.	4,762	60,139	0.01960
Illinois	M.C. & Wyo.	7-26-53	6-19-53	0.50	85.4—22-in.	5,676	79,630	0.01980
Illinois	M.C. & Wyo.	7-26-53	6-19-53	0.50	85.4—22-in.	4,280	60,045	0.02090
Oklahoma	M.C.	7-13-53	7- 2-53	0.50	7.0—24-in.	3,741	57,660	0.02670
Oklahoma	M.C.	7-13-53	7- 2-53	0.50	26.8—24-in.	3,769	58,107	0.02160
Oklahoma	M.C.	7-14-53	7- 2-53	0.50	90.1—24-in.	3,757	55,783	0.02070
Kansas	M.C.	7-16-53	7- 7-53	0.50	20.5—24-in.	4,746	71,698	0.01820
Kansas	M.C.	7-16-53	7- 7-53	0.50	59.7—24-in.	4,716	70,511	0.01910
Kansas	M.C.	7-17-53	7- 9-53	0.50	16.0—24-in.	5,459	78,198	0.02410
Kansas	M.C.	7-17-53	7- 9-53	0.50	46.6—24-in.	5,546	80,659	0.01970
Sohio Pipe Line Co.:								
Indiana	M.C. & Ill.	7- 1-54	6-21-54	14.00	43.2—12-in.	3,182	87,700	0.01860
Plantation Pipe Line Co.:	Products							
Georgia	Diesel fuel	9-19-53	7-10-53	3.00	54.2—14-in.	3,594	187,803	0.01590
Georgia	Gasoline	9-30-53	9-28-53	3.00	46.5—18-in.	6,007	876,752	0.01190
Great Lakes Pipe Line Co.:								
Oklahoma and Kansas	Gasoline	4-26-53	3-23-51	3.00	49.0—12-in.	3,838	844,000	0.01091
Standard Oil Co. (Indiana):								
Missouri	Gasoline	6-12-54	6- 1-54	1.50	96.9—12-in.	935	260,400	0.01390
Missouri	Gasoline	6-12-54	6- 4-54	1.50	104.6—12-in.	935	260,400	0.01410
Iowa	Gasoline	6-12-54	5-27-54	1.50	102.1—12-in.	935	260,400	0.01630

The rest was seamless. All traverse joints were welded by electric arc.

There was a slight change in inside diameter of pipe in several of the test sections. This necessitated conversion to an equivalent length representative of the majority of the pipe in the particular section. In practically all cases the inside-diameter differences were only small fractions. The noted exception was where 30-in. pipe—which represented more than 50 per cent of the section—was converted to 31-in. pipe.

Scrapers . . . Scrapers were run within 1 week before the tests in about two-thirds of the lines. In most of the remaining lines scrapers had been run within 3½ months preceding the tests. The frequency of running scrapers varied from one per week to one every 3 or 4 months. Experience with paraffin deposits and the consequent reduced flow or an increase in pressure determined and regulated scraper frequency.

Flow . . . Flow rates varied from about 2,000 bbl. per hour in 16-in. lines to more than 13,000 bbl. per hour in the 26 and 31-in. lines.

Tank gages were used in practically every case to determine the rate of flow. Test intervals ranged from 30 minutes to 1 week; however, most were within the 1 to 4-hour range.

Pressure . . . Differential pressures corrected for elevation differences are within a range of 11 to 1,122 psi. Because of the various lengths of line involved, a more suitable means of expressing pressure is psi. drop per mile. The pressures varied between 1.57 and 13.25 psi. with most of them between 4 and 12 psi. There was no correlation between psi. drop per mile and the size of line.

The discharge pressures were controlled and recorded automatically during the tests. Instruments of high accuracy, properly checked and calibrated, were supposed to be used. Notations indicate in most cases that both discharge and suction pressures were stabilized for several minutes before the beginning of the tests.

Oil characteristics . . . All tests were made when one type of crude oil or a mixture of similar crude oils completely filled the test section during the entire period of testing. Domestic crude oils were South Texas, North Texas, East Texas, Oklahoma, Kansas, Wyoming, and California (San Joaquin-Waxy). Foreign crude oils were Arabian-Stabilized, and Canadian (Redwater).

Viscosity and gravity determinations were made from samples withdrawn from the line during the test period. Whenever stabilized crude oils were being handled, or whenever previous testing had established the physical characteristics of the oil fairly well, samples were not taken.

The viscosity range was rather narrow. Most values were from 40 to 60 S.U.s. Only two tests involved crude oil having a viscosity greater than 80 S.U.s. These values were between 300 and 400 S.U.s., and the line tested was 16 in. in diameter.

Temperature . . . Average temperatures of the streams were from 47° to 106° F. The majority were between 50° and 80° F., which is indicative of average annual and summer temperatures.

Temperature variations were very small at the initial and terminal ends of the test sections. However, varia-

TABLE 2—COMPARISON OF FRICTION FACTORS—STANTON AND PANNELL DATA VS. TEST DATA

Company—	Size (in.)	Rate of flow, bbl./hr.	Calculated— Reynolds number "R"	Calculated— Friction factor "F"	Stanton-Pannell "F"	Calculated percentage Pr. of design
Mid-Valley Pipe Line Co.	20	8,217	223,794	0.01518	0.0153	99.2
West Texas Gulf Pipe Line Co.	26	13,108	247,017	0.01424	0.0151	94.3
	26	12,568	236,841	0.01467	0.0152	96.5
	26	11,656	219,655	0.01492	0.0154	96.9
Pan American Pipe Line Co.	26	7,595	185,954	0.01605	0.0158	101.6
Trans-Arabian Pipe Line Co.	31	13,765	174,000	0.01610	0.0160	100.6
Service Pipe Line Co.	20	6,376	258,200	0.01473	0.0149	98.9
	20	6,250	253,100	0.01472	0.0150	98.1
	20	6,040	230,790	0.01541	0.0153	100.7
Interprovincial Pipe Line Co.	20	6,520	51,330	0.02055	0.0207	99.3
	20	6,686	52,110	0.02020	0.0206	98.1
	20	6,588	53,200	0.02070	0.0205	101.0
	20	6,520	53,080	0.02040	0.0205	99.5
Standard Oil Co.—California	18	4,633	68,800	0.01960	0.0194	101.0
Magnolia Pipe Line Co.	16	2,171	46,819	0.02087	0.0212	98.4
	20	4,868	90,904	0.01753	0.0183	95.8
	20	4,551	84,455	0.01834	0.0185	99.1
Portland Pipe Line Co.	18	5,436	70,958	0.01919	0.0192	100.0
	18	5,485	59,243	0.01956	0.0200	97.8
	18	5,457	80,322	0.01859	0.0188	98.9
Humble Pipe Line Co.	16	2,140	4,462	0.03677	0.0402	91.5
	16	3,219	5,896	0.03600	0.0370	97.3
	18	2,846	36,887	0.02136	0.0224	95.4
	18	3,504	50,386	0.02033	0.0208	97.7
	20	4,752	232,646	0.01591	0.0152	104.7
	20	7,075	105,111	0.01831	0.0178	102.9
	20	7,000	274,030	0.01678	0.0148	113.4
Sinclair Pipe Line Co.	22	4,990	76,796	0.01730	0.0190	91.1
	22	5,026	73,498	0.01860	0.0191	97.4
	22	5,131	71,259	0.01870	0.0192	97.4
	22	5,793	80,312	0.01870	0.0188	99.5
	22	4,762	60,139	0.01960	0.0199	98.5
	22	5,676	79,630	0.01980	0.0188	105.3
	22	4,280	60,045	0.02090	0.0199	105.0
	24	3,741	57,660	0.02670	0.0201	132.8
	24	3,769	58,107	0.02160	0.0201	107.5
	24	3,757	55,783	0.02070	0.0203	102.0
	24	4,746	71,698	0.01820	0.0192	94.8
	24	4,716	70,511	0.01910	0.0193	99.0
	24	5,459	78,198	0.02410	0.0189	127.5
	24	5,546	80,659	0.01970	0.0188	104.8
Sohio Pipe Line Co.	12	3,182	87,700	0.01860	0.0185	100.5
Products—						
Plantation Pipe Line Co.	14	3,594	187,803	0.01590	0.0158	100.7
	18	6,007	876,752	0.01190	0.0126	94.4
Great Lakes Pipe Line Co.	12	3,838	844,000	0.01091	0.0127	85.9
Standard Oil Co. (Indiana)	12	935	260,400	0.01390	0.0150	92.7
	12	935	260,400	0.01410	0.0150	94.0
	12	935	260,400	0.01630	0.0150	108.7

tions were from 0° to 7° F. between the initial and terminal end. The one exception had variations as high as 15° F. In this particular case the crude oil was used to cool engines while passing through the station.

Equipment . . . Driver and pump equipment was divided fairly evenly between diesel centrifugals, electric centrifugals, diesel reciprocating, and electric reciprocating.

Closed-line operation was the method employed in most test sections, and discharge pressure was controlled automatically.

Test Results

Table 1 is a summary of general information and results of the tests.

The results of the tests upon which evaluation of design is based for larger diameter lines are Reynolds number and friction factor. These are computed values derived from known conditions which exist (such as length of line, size of line, and elevation difference at ends of the test section) and measured values obtained during the testing operations (such as suction and discharge pressure, rate of flow, viscosity, and gravity of crude oil or petroleum product).

Fig. 1 . . . The results of Stanton and Pannell's experimental work published in 1914 are used to compare these data.[1] Stanton and Pannell experimented with air and water flowing at different rates through smooth drawn brass pipe of different diameters. Their work has been confirmed by later experiments on different fluids. Results of tests conducted on crude-oil lines in the 1920's on 6 to 12-in. pipe coincided very closely with Stanton and Pannell's data.[2]

The Stanton and Pannell relationship of coefficient of friction or friction factor to Reynolds number is shown by Fig. 1. Also shown are test points for 16, 18, 20, 22, 24, 26, and 31-in. pipelines as supplied by participating companies in the friction-loss tests.

Fig. 2 . . . Supplemental data were obtained for 16, 20, and 30-in. pipelines. The plotting of these additional points is shown in Fig. 2. Practically all points correspond very well to Stanton and Pannell's data within this range. The two 24-in. points at Reynolds numbers of 57,000 and 78,000 involved short test sections, thereby reducing the accuracy of the tests when comparable measuring devices for longer test sections are used.

The variation band of Stanton and Pannell's data is about 2 per cent each side of the mean curve. Actual operating variation is greater than this as indicated by the tests. The number of people involved, the different methods employed, and the common problems of obtaining reliable viscosity data—coupled with the fact that these tests were run by the various operating companies — precludes finer corroboration than that obtained.

From data obtained it is not possible to say that a relationship exists between friction factor and size of pipe. We would assume that the relative roughness effect, and consequently the friction factor, would decrease with an increase in the pipe diameter.[3]

Table 2 . . . In Table 2 are shown calculated Reynolds numbers and friction factors as derived from the tests performed. These are the same values as were shown in Table 1. Also friction-factor values selected from Stanton and Pannell's curve for corresponding Reynolds numbers are shown for comparison.

Based on Stanton and Pannell's curve as design, pressure losses for corresponding flow rates expressed as a percentage of design are shown in the right-hand column.

There is not a direct relationship between friction factor and Reynolds number for the turbulent-flow region. This has resulted in the development of many formulas. The lack of agreement is that developers select different points as well as different ranges on the Stanton and Pannell curve, or other friction-factor curves, for the establishment of a direct relationship between friction factor and Reynolds number.

A formula has been developed which covers the range of operation experienced in these tests. The direct Reynolds number friction-factor relationship was established, as shown in Fig. 3, by drawing a straight line between points on the Stanton and Pannell curve corresponding to Reynolds numbers of 40,000 and 250,000. By writing an equation for this line and substituting in other hydraulic formulas, the formula shown in Fig. 3 was derived.

This formula has little practical use because of its limited range. It was developed purely to reflect the operating conditions encountered in this investigation. Its use is especially limited in the lower Reynolds number range, commonly encountered in smaller-diameter pipe in crude-oil service, and in the very high Reynolds number range, such as gasoline lines.

References

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3. L. F. Moody, "Friction Factors for Pipe Flow," Trans. A.S.M.E., 66, 671-84 (1944).

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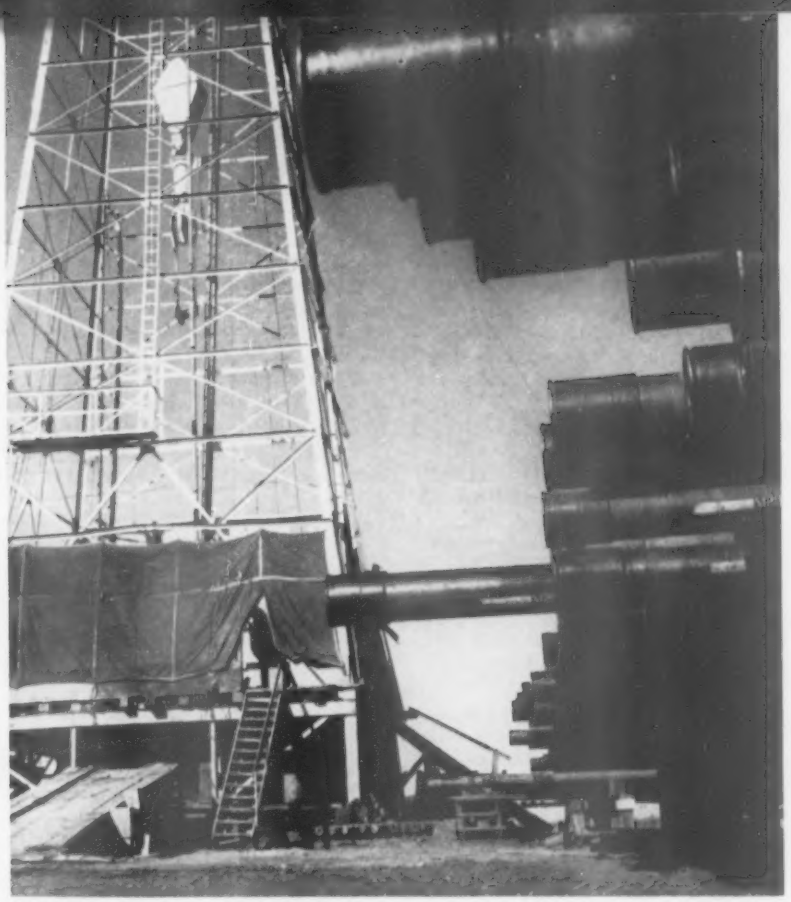

OIL-WELL CASING stacked at well site. Considerable work is now being done on A.P.I. standards for such casing.

Here's the current story on

A.P.I. Tubular-Goods Standards

by H. W. Ladd

A.P.I. Standard 5A: "Specification for Casing, Tubing, and Drill Pipe," published in its nineteenth edition in March 1954, includes for the first time a provision for mandatory hydrostatic testing at the mill of all grade N-80 casing and tubing to 80 per cent of its specified minimum yield strength.

The A.P.I. Mellon Institute fellowship was reactivated to study a thread compound containing a soap-base vehicle and costing about one-fifth as much as the silicone-vehicle compound officially adopted by the American Petroleum Institute.

Other current studies include development of specifications for: casing of grade higher than N-80; high-strength oil-well tubing; integral joints for tubing and casing; tubing with walls heavier than the present standards; and high-strength drill pipe. Suggestions for reducing present roll sizes were investigated, but it was decided to take no action.

Improvements and additions are incorporated in A.P.I. Standard 5L: "Specification for Line Pipe," and A.P.I. Standard 5LX: "Specification for High-Test Line Pipe"—both to be reissued this year.

An A.P.I. subcommittee on plastic pipe was recently appointed to develop standards for plastic pipe for oil-field applications.

Casing testing . . . It took about 8 years to set up the program for mill testing N-80 casing. The mills had to be sold on the oil industry's need for such testing to the extent that the expenditure of several million dollars for high-pressure testing equipment would be justifiable. It is quite generally agreed now that this high test goes a long way toward assuring the quality of this product.

Author is associated with Stanolind Oil & Gas Co., Tulsa. Paper presented at annual meeting, A.P.I., Chicago, November 9, 1954.

Thread-Compound Development

The A.P.I. thread-compound development project with Mellon Institute produced the A.P.I. high-pressure thread compound. When the research work was discontinued, there were some uncompleted tests being conducted on cheaper compounds containing a soap-base vehicle instead of the silicone vehicle used in the first-mentioned compound.

Because one pipe manufacturer has adopted the use of this alternate compound, which is found to be of high quality, the American Petroleum Institute has reactivated the Mellon Institute fellowship to complete those tests. Results will soon be available, and field tests will probably be made thereafter. If the alternate compound proves itself suitable, it also may be adopted by the Institute, possibly for use under circumstances where maximum joint-leakage protection is not required. Its cost is about one-fifth of that of the silicone-base compound. As the importance of using an adequate thread compound on A.P.I. joints becomes more generally recognized, the use of compounds made under the formulas developed by the Institute is steadily increasing.

Specifications in process . . . We have not yet been able to determine specification requirements for a casing grade higher than N-80. Differences in processes of manufacture seem to provide the main difficulties in establishing a uniform specification. The mills have yet to agree on the physical properties for the specification—mainly as to whether the minimum yield strength shall be 105,000 or 110,000 psi.

Two mills are now marketing 110,000-lb.-yield-strength casing. A smaller quantity of 105,000-lb. casing is being produced. But there is not enough high-strength casing being made available to satisfy industry demands. Other mills are installing or planning to install the equipment necessary to make such casing, but any considerable increase in production seems a long way off.

The possibilities of developing standard specifications for high-strength oil-well tubing is even more complicated. Only two companies with oil-country mills make 105,000-lb.-yield-strength alloy-steel oil-well tubing and show it in their price lists. Other companies with oil-country and specialty mills, and companies with specialty mills only, furnish such alloy tubing from

the specialty mills with chemical and physical properties as may be agreed upon with the purchaser.

Apparently user demand for high-strength oil-well tubing is divided into two general classifications: (1) those who want it made of an alloy steel which will produce physical properties adequate to resist high-tensile and internal stresses; and (2) those who desire it made of an alloy steel which will inhibit corrosion in addition to providing high strength.

The result has been the production and use of high-strength alloy tubing in a large variety of alloy steels and dimensions with consequent differences in chemical and physical properties, and in cost. Tube walls heavier than standard are also in demand. The manufacturers can be of much more service than they have been in supplying this special tubing by helping the user select steels most economical for his conditions of service.

Tubing demand . . . High-strength alloy-steel tubing is in considerable demand and, with the many sources of supply, is more readily available than high-strength casing. It should be mentioned here that the pipe committee is not now contemplating the inclusion of requirements for corrosion-resistant pipe in its standard specifications.

In response to specific demand, we have been working for some time on a standard design of integral joints for tubing and casing, and also on standards for tubing with walls heavier than the present standards—these now being particular activities of our research subcommittee. They tie into the high-strength casing and tubing specifications just discussed, and are also to be available for J-55 and N-80 grades.

Twofold problem . . . The integral-joint problem has logically been divided into two parts—the first dealing with joints employing A.P.I. threads and, as nearly as possible, A.P.I. dimensions; the second part considers joint designs involving special threads, special dimensions, and probably mechanical seals. Considerable progress has been made on the first phase, but the second is more complicated and has many more controversial points to be settled before any standard design can be agreed upon.

The high pressures constantly being found emphasize the need for heavier walls in oil-well tubing, as well as for higher-strength grades. The wall thicknesses agreed upon must hold the pressures indicated and lend themselves to all the problems involved in mill production and field use. Furthermore, there is the possibility—even the probability—that heavier-wall larger o.d. couplings will be necessary for getting maximum leak resistance out of these joints.

It appears probable that standard specifications will be developed on these items in the not-too-distant future. The work on integral joints will be wasted if the petroleum industry does not present a demand for this material in quantities which will justify its production.

Formative Stage . . . High-strength drill-pipe specifications are also in the formative stage. Specifications on drill pipe for use with welded-on rotary connections have been agreed upon, as well as specifications on drill pipe with integrally-forged connections.

There is an adequate basis for our present casing-size selection, and there is a long period of usage to support it. Since the adoption of the present list of sizes the tendency of users has always been to increase it rather than reduce it. We know of no drilling or operating condition, however, which has not been met with the present sizes, and no real justification for adding to them has been presented.

The mills have continued to produce casing in standard roll sizes only, inasmuch as regulations were removed which previously made it necessary for them to do so, and it is to everyone's best over-all interests that they stay with the standards.

Starting with 4½-in., casing sizes increase on the ratio of approximately 12½ per cent, with due allowance in actual percentage of increase necessary to use already existent roll sizes and maintain required clearances in larger sizes. The only place in the list where there are two sizes instead of one, in this rational progression of size increase, is between 5½ and 7 in. These sizes are 6 and 6⅝ in. The two could be replaced by a 6¼-in.-o.d. size. Both 6 and 6⅝-in. had already existed, and were sizes in the low-tonnage production bracket, although still in regular demand. Going to the tremendous expense involved in changing over to this 6¼-in. size has not been justifiable so far. Demands change with conditions. It, therefore, may be practical to make the change later on, or even to eliminate one of the present sizes.

Casing need . . . The ratio of increase in size is as large as it should be to protect the variety of casing programs required to meet all operating conditions. Widening the gap to make fewer sizes or the elimination of any of the existing sizes could cause difficulties in meeting all conditions and could react to the economic disadvantage of the user by limiting his selectivity, with consequent increase in tonnage. We must not eliminate any casing size which might be the only one capable of meeting certain specific conditions of use.

In the opinions obtained on the elimination of grades there was little objection to eliminating grade F-25, which covers lapweld material—although one district did not want to see the lapweld process ruled out of the American Petroleum Institute. There are but two or three mills which make casing and tubing by this process. As the production of lapweld material does not interfere with the production of seamless or electric-weld items, and as a considerable quantity of lapweld casing and tubing is being economically used, there seems to be no essential reason to remove grade F-25 from the standard.

Each size of casing starts out with an F-25 item which has a wall thickness as thin as, or thinner than, any other item listed. This is, therefore, the item with the least strength in its size because of the combination of the thin wall and the low physical properties of the grade.

H-40 grade . . . The next item is usually in the H-40 grade, either in the same or in a slightly heavier weight. The physical properties of this grade are higher and, therefore, the item is more capable of withstanding the possible collapse, tensile, and internal stresses which are necessary to consider when casing and tubing is applied to oil-well usage.

From there on, the H-40 items increase in wall thickness and performance properties, but the increments are spaced widely enough apart to hold the number of items at a practical minimum.

When the wall thickness in grade H-40 has increased to a point where the desired increase in performance properties can be picked up by the grade J-55 to advantage, it proceeds in the same manner, and then on into grade N-80. This rational basis of grade and weight distribution reduced the number of specified items tremendously.

The 8⅝-in. 24-lb. J-55 has about the same performance properties as 8⅝-in. 28-lb. H-40; and 7-in. 26-lb. J-55 duplicates the performance properties of 7-in. 23-lb. N-80. Each was necessary to satisfy the special requirements of a particular district. Otherwise the list consistently maintains a uniform rate of progression in performance properties.

The elimination of H-40 items would leave us with the lightest J-55 item to take their place or the necessity for developing substitute items. We find no technical reason why grade H-40 should

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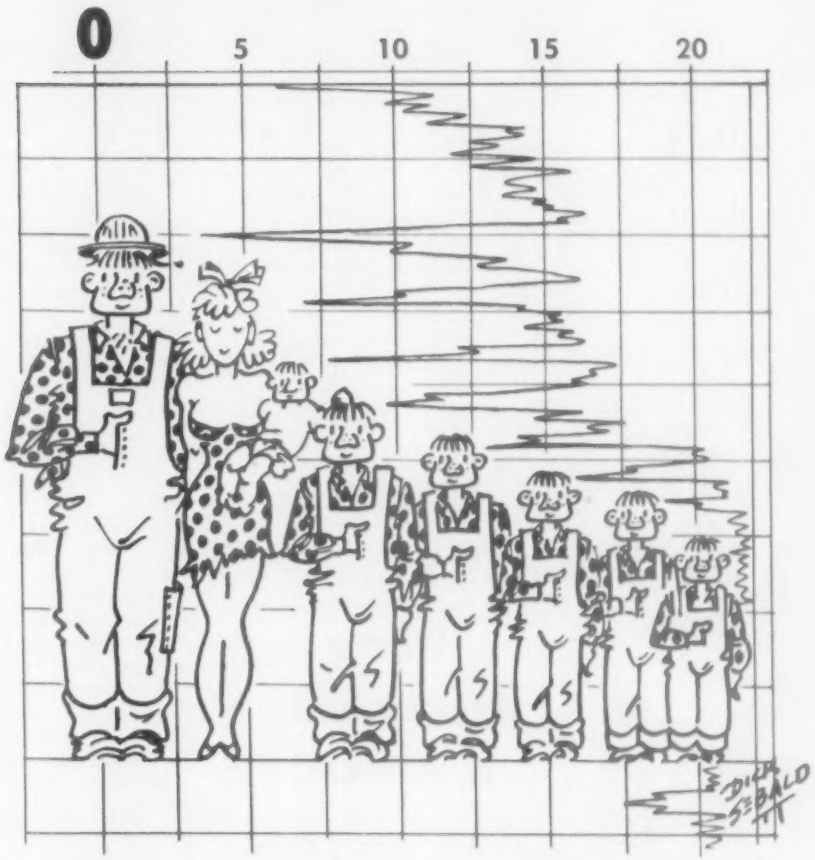

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be eliminated and, therefore, there is no objective in so doing unless the grade J-55 items could be adjusted in a manner which would protect the users' economy.

A partial answer would be to provide new items in grade J-55 with walls lightened enough to balance out the difference in cost between the two grades. It was concluded that such walls would be too thin in many cases to be satisfactory from a manufacturer's or user's standpoint.

The basic thinking expressed by all our districts was that further simplification of grades would offer no advantage to the user. One district wanted more items in grade N-80, as well as in grades J-55, if grades F-25 and H-40 were eliminated. A manufacturer did not want to have grade H-40 eliminated because it served as a protection to the mill on heats of grade J-55 which might run under the minimum yield strength of 55,000 psi. for that grade.

All of our standard pipe specifications are now in process of revision to reflect the approved actions taken at the pipe committee meetings last June. The specifications have been strengthened by the deletion of provisions subject to agreement between the purchaser and the manufacturer wherever possible. By doing this, the specifications are on a more positive basis, and more clearly reflect what is to be expected when material is purchased under them.

A.P.I. Standard 5L: "Specification for Line Pipe" and A.P.I. Standard 5LX: "Specification for High-Test Line Pipe" are to be reissued yet this year. Important improvements and additions will be found in both of them under the stipulations for chemical requirements; mill-product quality tests; and dimensional controls. Grade "C" has been removed from Std. 5L, in the interests of weldability control.

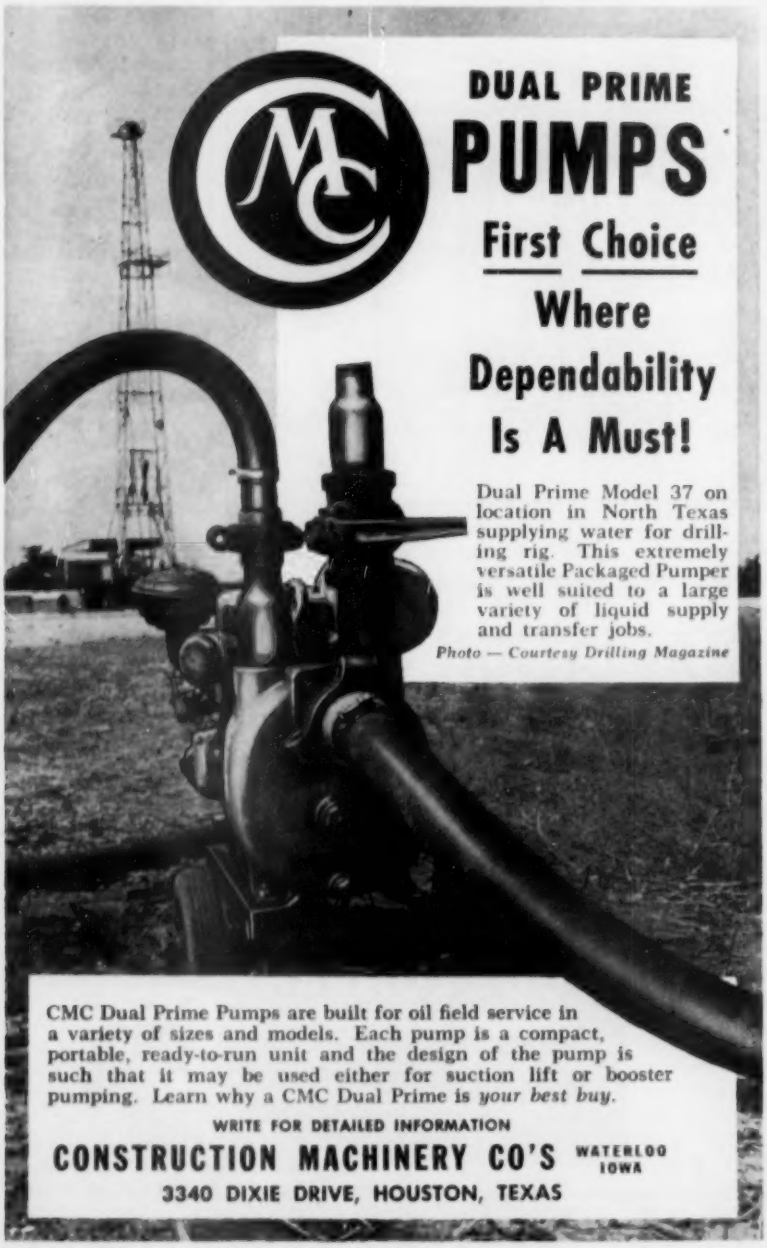
Further important changes in Std. 5LX include the addition of requirements for the qualification of welders and welding procedures at the mill, the addition of welding and weld-testing controls on submerged-arc welded pipe, and the reduction of allowable wall thickness tolerance for large-diameter pipe.

Many of these changes are the result of the active part taken by A.P.I. pipe committee members on Subcommittee 8: Gas Transmission and Distribution Piping, a section of American Standards Association Sectional Committee B31 on Code for Pressure Piping.

It is expected that the Section 8 part of the code will be issued late this year. It will incorporate these A.P.I. line-pipe standards, and the line pipe to be produced under these revised standards will be adequate to meet all code requirements of use.

Subcommittee 9 on Oil Transportation Piping (another new section of B31) has started recently to produce a code for its specific type of usage. It is expected that the revised A.P.I. line-pipe specifications will be acceptable for those uses also. If not, we shall make every effort to meet their special demands.

New committee . . . An A.P.I. subcommittee on plastic pipe, recently appointed, will work in close contact and cooperation with the pipe divisions of the Society of the Plastics Industry, Inc., and other society committees on plastic pipe and fittings.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The locations and status of Alberta oil wells are contained in the book scaled 4 miles to the inch. This scale allows the development of geological features, land pictures, and drilling and exploration programs on the individual maps. Each page is dated; and by subscribing to the revision service, the user will be able to substitute pages containing current well information at 3-month intervals.

VALVE STOCKS are easier to maintain, and inventories can be cut if valves are standardized where possible for refinery use. Photograph courtesy Carter Oil Co.

WAREHOUSE OPERATIONS can be made simpler and more economical if fittings and similar equipment are standardized. Photograph courtesy Stanolind Oil & Gas Co.

Are high inventories eating into profits? Here's how refiners can effect

SAVINGS THROUGH STANDARDIZATION

by C. S. Perkins

EIGHTY-FIVE per cent of refiners replying to a questionnaire stated that the lack of standardization of refinery equipment is a current problem in their companies. Specific problems arising from this lack include higher inventories, less availability, and higher purchase and maintenance costs.

Seventy-five per cent of the companies report considerable progress in the development of company standards for exchanger tubes. Specific examples are cited of inventory reductions resulting from standardization of exchanger tubes, heater tubes, and heater-tube fittings.

Standardization of bubble caps would not decrease inventories, but would reduce purchase and maintenance costs. Lack of standards of heater tubes remains the most serious refinery standardization problem. Its solution involves restricting the heater designer to a list of standard tubes. The adoption of company standards can increase the availability of heater tubes; but, for an over-all solution of the problem, the development of an A.P.I. standard for refinery-type fired oil heaters is recommended.

Author is associated with Union Oil Co. of California, Los Angeles. Paper presented at annual meeting, A.P.I., Chicago, November 9, 1954.

Questionnaire . . . Answers to the questionnaire revealed that, although there has been some progress in the field of refinery - equipment standardization, there is still a vast amount of work ahead. As might be expected, the standardization programs in the different companies showed various stages of development, ranging from well-established programs to tentative plans.

It is interesting to note the different methods used to accomplish standardization. One company has a formal standards department, charged with the responsibility for developing standards. Another company has a formal standards committee with the same responsibility. However, most companies develop standards on an informal basis. This is usually done by joint conferences between the engineering, maintenance, and purchasing departments—with the latter often spearheading the drive.

Practically all companies are keenly interested in standardization. Eighty-five per cent of those replying stated that the lack of standardization of refinery equipment currently is a problem in their company. The other 15 per cent reported that the lack of standardization was a problem at one time, but these problems have been corrected by the establishment of company standards.

Specific Problems

If the lack of standardization in general is a problem, what are some specific problems this lack of standardization causes? Replies to the questionnaire indicated that the following specific problems are involved:

1. Higher inventories: Eighty-five per cent of those replying felt that higher inventories resulted from the lack of standardization.

2. Higher purchase cost: Three companies out of every four replying stated that higher purchase cost resulted.

3. Less availability: Sixty per cent of those replying indicated that equipment was less available where there was no standardization.

4. Higher maintenance costs: Two companies out of every three replying stated that higher maintenance costs resulted from the lack of standardization.

Current progress . . . The questionnaires revealed that considerable progress has been made in the development of company standards for exchanger tubes. Seventy-five per cent reported progress along these lines. Many reported success in reducing exchanger-tube inventories by means of standardization.

A good example of this reduction was given by one company. Its purchasing, engineering, maintenance, and stores departments made a study of the purchase, storage, and inventory of admiralty condenser tubes. As a result of this study the number of diameters was reduced from four to three, and the number of different lengths was reduced from eight to four.

What effect did this have on its inventories? Prior to standardization it was necessary for this company to carry a protective stock of 13 per cent of the total tubes in service; after standardization it now carries a protective stock of 4 per cent of the total tubes in service. On a dollar basis, this company was able to reduce its inventory of admiralty exchanger tubes from $175,000 to a current level of $75,000.

Some payoffs . . . This experience is not a fluke. Ten other companies reported substantial reductions in exchanger-tube inventories as a result of standardization programs. Most companies felt that still greater reductions in inventory would be possible as soon as nonstandard units were depreciated. Nevertheless, even at this stage, those with standardization programs in progress reported that they carried a protective stock of 10.5 per cent of the tubes in service. Those who reported no standardization find it necessary to carry a protective stock of 16.4 per cent of the tubes in service, or 56 per cent more inventory than companies with standardization programs. This is concrete proof that standardization pays off.

Other Side of Picture

Unfortunately, the industry is not making comparable progress in the field of heater-tube standardization. Only 11 companies reported the development of any company standards for heater tubes. And what has been the result of this lack of standardization? The industry as a whole is carrying a protective stock of 26.6 per cent of the total heater tubes in service.

The average protective stock carried by companies with no company standards amounted to 31 per cent of the tubes in service. The average protective stock carried by companies with company standards was 16.2 per cent, or approximately half of the inventory carried by companies with no heater-tube standards. Several firms with company standards felt that still further progress in inventory reduction would be made soon as nonstandard heaters are replaced.

Why? . . . Why has not more progress been made in heater-tube standardization? It is agreed that intricate factors are involved in the design of heaters. Such factors as flow rates, heat-transfer coefficients, pressure drops, and draft losses are important, as they affect the onstream efficiency of the heater. All of these factors are carefully considered by the designer.

Does the designer also consider the cost of carrying special tubes in inventory, with its consequent costs of money tied up, taxes, insurance, obsolescence, deterioration, and physical storage probably totaling 25 per cent of the value of the tubes each year? Does he consider the advantage of interchangeability from inventories for different end uses? Does he consider the cost advantages of buying more tubes of fewer sizes? Does he consider the cost of carrying special headers to accommodate special size tubes?

Usually he does not. Indeed, he is given such wide latitude in making his selection of tube diameter, thickness, and length that a new heater invariably results in the stocking of a flock of special tubes. Each time this happens, the inventory takes a substantial increase. Our inventories will continue to increase until the designer is informed of these problems, and restricted to a reasonable list of standard tubes for design purposes.

What Can Be Done

When the designer is presented with a list of standard tubes, he will probably protest that it will be necessary to sacrifice operating efficiency, or the construction cost will be higher if standard tubes are used. But let us not be deluded into thinking that it is possible to obtain good operating efficiency only with special tubes.

By changing the number of tubes in a heater or by changing the number of passes, the designer can come up with practically the same result by working with a reasonable list of standard tubes. And let us not look at the savings involved in the initial cost of a heater, and then ignore the inventory and other costs which will probably amount to several times this saving during the life of the heater. The problem is one of ultimate costs, not first costs.

Here is a good example of the reduction of inventories possible through the standardization of heater tubes. One company reported that, as a result of its standardization program, it was able to reduce the number of different diameters from 10 to 4, and the number of different lengths from 16 to 5. What did this reduction mean in terms of inventory? It was able to reduce its heater-tube inventory 35 per cent, with still further reduction possible.

Another company reported that its standardization program reduced the number of heater-tube diameters from 12 to 5, the number of different lengths from 19 to 4, and the number of different materials from 11 to 9. A 30 per cent reduction in heater-tube inventories has been realized already.

How about this? . . . Several companies stated that they were attempting to obtain standardization by limiting the tube sizes on new installations to those already being stocked. Although this approach is better than none, it leaves much to be desired. In the first place, it will not be possible to reduce inventories in this manner. The best that can be expected is that the inventories will not increase. A reduction of inventories will be brought about solely by a decrease of the different types of tubes stocked.

Furthermore, the use of current sizes for design purposes will result in the perpetuation of many odd-size tubes in your inventory. It is significant that the average oil company carries 10.4 different diameters, 6 different materials, and 32 different lengths of heater tubes in its inventory. Surely we should not be satisfied with holding the number of different tubes to this level.

And this? . . . Heater-tube fittings represent another opportunity for the reduction of inventories by standardization. One West Coast oil company reported that one of its refineries carried 35 different types or sizes of heaters and 51 different types or sizes of tube supports, with a total inventory value of $44,000.

The standardization of these fittings

would not only reduce the inventory, but would simplify maintenance, reduce design time, and permit competitive bidding of these parts. Only 11 companies stated that they had developed any kind of standards for heater-tube fittings. There is a great opportunity for standardization here.

The standardization of bubble caps would not result in decreased inventories for the reason that, unless company standards have been developed, generally no attempt is made to stock them because of their nearly infinite variety. However, if standards were developed, it would certainly result in more economical purchase cost, and would reduce maintenance costs.

One manufacturer of bubble caps carries a standard line of 223 different types and sizes in his catalogue. Add the special caps which he manufacturers to this total, and it is easy to see why the lack of standardization is such a problem. Under some conditions it is probably necessary to use special bubble caps. However, standard caps of two or three different sizes probably would be adequate for most services.

Additional items such as refinery pumps, refractory shapes, and line blinds also need standardizing, but it is important that we do not scatter our efforts by working on too many projects at one time.

The Pressing Problem

The most pressing problem facing us today is the lack of standardization of heater tubes. Most oil companies have more money tied up in heater-tube inventories than any other item. In spite of this, there has been little progress in the most effective way of reducing these inventories. A few companies have developed company standards for this item, but our real need is the development of industrywide standards.

Company standards are a step in the right direction—industry standards are a step in the right direction—industry standards give us several additional benefits. The most important of these is better availability. If several oil companies in one locality use the same size heater tubes, jobbers will be more willing to carry spare tubes in stock. Also, in the event of a real emergency, tubes could be borrowed from other oil companies on a temporary basis.

Mill runs of standard sizes would be scheduled more frequently. Industry standards would also facilitate the sale of surplus tubes by any oil company, because there would be a larger market for the tubes. Currently we are trying to sell $75,000 worth of surplus heater tubes, but have had little success due to the fact that most of these sizes are not used by other companies.

A.P.I. standard? . . . An A.P.I. standard should be developed for refinery-type fired oil heaters—a standard which will give the design engineer reasonable latitude in which to obtain good operating features, and still be restrictive enough to permit a reduction in the types of tubes carried in stock.

Fortunately there is an able committee on refinery-equipment standardization within the American Petroleum Institute organization. We should ask this committee to study the problem. If its study confirms that this lack of standardization is a real problem as it applies to ultimate costs, it will come up with some recommended industry standards which will go a long way toward alleviating our problems.

Instead of developing further company standards, let us unite behind a drive for industry standards. In that way we can obtain all of the benefits of standardization instead of just a portion. The questionnaires reveal that 91 per cent of you favor industry standards for heater tubes. Now is the time to do something about it. Thought without action is of no value. Let us get the machinery into action for industrywide heater-tube standards now.

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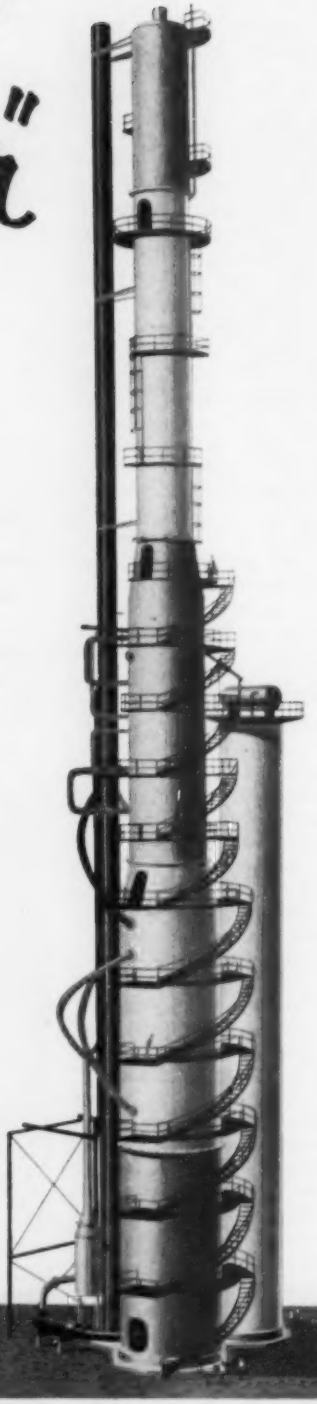

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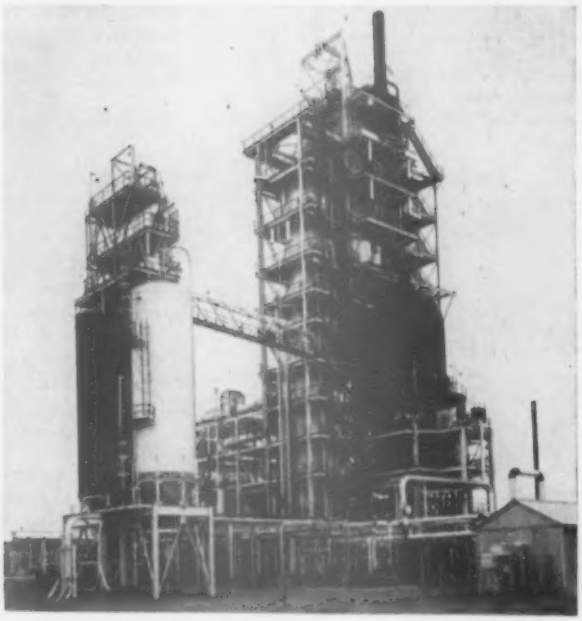

The Oil Industry Is More Integrated

Than You Might Think—Here's Why

by John G. McLean

A HARVARD BUSINESS SCHOOL research study confirms that vertically integrated companies occupy a more important position in the petroleum industry than in almost any other United States industry. The tendency toward vertical integration is most pronounced with respect to the crude-oil trunk and products pipelines.

Factors which have favored oil-industry integration include:

- Fluctuations in profit opportunities at the different levels of the industry.
- The nature of the risks associated with capital investments in the oil business.
- Opportunities for cost reductions.
- Management opportunities for improved strategies in planning operations and utilizing capital funds.

The process of integration in the oil industry has been characterized by a high degree of individualism, has not

Author is professor of business administration, Harvard University, Cambridge, Mass.
Paper presented at annual meeting, A.P.I., Chicago, November 8, 1954.

destroyed the opportunities for small nonintegrated companies, and often has intensified rather than threatened competition.

Integration Widespread

It is a matter of historical record that vertically integrated companies have occupied a more prominent position in the affairs of the oil industry than they have in almost any other industry in our economy. A vertically integrated company is one which engages in the ownership, management, or control of more than one of the major steps in the oil process such as crude-oil production, transportation, refining, wholesale marketing, or retail marketing.

Our data revealed that in 1950 at least 87 of the operating refining companies, or 48.6 per cent of the total number in the industry, had some type of integrated structure.* Moreover, the large companies were exclusively of the highly integrated type. All companies with refining capacities in excess of 50,000 bbl. per day were engaged in producing, refining, wholesaling, and retailing activities,† and there were not more than three companies with capacities in excess of 20,000 bbl. per day which did not have some type of vertical integration.

These integrated companies conducted a very large share of the industry's affairs. They owned or leased 35.4 per cent of the producing wells, 85.4 per cent of the crude-oil gathering lines, 82.1 per cent of the crude-oil trunk lines, 93.2 per cent of the crude-oil charging capacity, 92.2 per cent of the products pipelines, and 51.6 per cent of the service stations. With one or two exceptions, the proportion of the industry's operations conducted by the integrated companies was even larger than the share of the industry's facilities which they held at each major level of the business.

There is no single point in the oil process where the tendency toward vertical integration has been more pronounced than with respect to the ownership and operation of the crude-oil trunk and products pipelines. From the very early days of the oil industry down to the present time, the great majority of the pipelines have been owned and operated, as they were in 1950, by producing or refining companies or by their subsidiaries and affiliates.

*There was clearly more integration in the industry than these figures indicate because 73 small concerns did not respond to our survey questionnaire and because our survey did not cover all types of integration, particularly integration across the wholesaling and retailing levels of the industry by companies engaged solely in marketing.

†All companies owning or leasing service stations were counted as participating in the retailing field, although some of these companies rented all or nearly all of their stations to independent dealers for operation.

Conditions Favorable to Integration

The extensive growth of large, integrated companies was by no means a matter of economic accident. Nor did it have its primary genesis in any collusive action, in a drive for monopoly advantages, or in the willful intent of particular company managements or groups of company managements.

The large, integrated companies have grown because the economic climate in the oil industry has been generally favorable to the integration process for a long period of time. The favorable climate, in turn, has resulted from the interplay of a vast complex of economic and business conditions.

Four of those conditions have been particularly important.

Profit opportunities . . . In the first place, integration in the oil industry has been encouraged by the behavior of the profit opportunities at the different levels of the business.

Historical records for the 33-year period 1920 through 1952 demonstrate conclusively that the gross margins and profits available at the different levels of the industry have been continually shifting and changing and that the movements at one level have frequently differed both timewise and directionwise from movements at another. Gross margins and profits have thus often been decreasing at one level while they have been stable or increasing at other levels.

By operating across two or more levels of the industry, a company has therefore been able to gain considerable protection against wide fluctuations in its profit position and against the short-term economic shocks developing from time to time in individual parts of the business.

Of particular significance is the fact that profit opportunities at the refining level of the industry, the central point in the oil process, have been extremely unstable, and that both forward and backward integration from the refining position have provided a very significant means by which greater stability of earnings could be obtained.

The role of the crude-oil and products pipelines in this connection has been very important. Earnings from pipeline operations in recent years have not been high relative to those available in other parts of the oil business, particularly since the advent of the pipeline consent decree in 1941 which limited the dividends a shipper-owner could draw from a pipeline company. However, pipeline earnings have tended to be somewhat more stable than those available in other parts of the business.

Moreover, such fluctuations as have occurred in pipeline earnings have frequently differed from those occurring in other phases of the industry. As a result, integration into pipeline transportation has provided a very important means by which a producing, refining, or marketing company could offset some of the profit fluctuations in other parts of its business and thus improve the stability of its over-all earnings experience.

In gaining protection against wide fluctuations in its profit position, an integrated company not only avoids large, short-term losses, but also foregoes the opportunities for large, short-term gains. Nevertheless, stability of earnings is an extremely important asset under most circumstances.

Of paramount significance is the fact that a company with stable earnings has a uniform flow of funds coming into the business which may be used for new capital investments. Stability of earnings likewise enhances the capacity of a company to borrow or to float new stock issues when its capital needs exceed its own immediate resources.

Therefore, an integrated company drawing profits from several different levels of the industry can often carry out long-range programs of capital investments on a more orderly basis than can a nonintegrated company whose profits are continually fluctuating in accordance with economic changes at a single level of the industry.

Stability of earnings also permits a company to offer continuing employment to management and labor, to conduct long-range programs of research and development on an uninterrupted basis, and to give the stockholder a more uniform return on his investment. Likewise it facilitates the development of pension plans and other employe benefits and contributes to stability in our national business expenditures for capital goods and in our national consumer purchasing power. For all these reasons stability of earnings contributes much to the health and security of the individual firm and also to the health and security of our entire industrial economy.

It is, therefore, somewhat ironical that the stabilization of gross margins and net profits should be one of the principal grounds upon which vertical integration has been attacked. For at least a quarter of a century those who favor divorcement legislation have been insisting that the vertically integrated companies "use profits made at one level of the industry to subsidize losses incurred at another."

These three points are pertinent regarding this contention:

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Mills Plastic III pipe weighs only about 1/10 as much as metal pipe of the same diameter, yet it takes on the toughest jobs. It speeds installations amazingly because it can be cut with an ordinary hand saw, and can be quickly joined with Milex fittings and Mills Plastic III Solvent. (The simple technique is shown at right. Flange adapter unions are available to adapt from S.W.P. sizing to iron pipe thread where required. Ask your distributor for details, or write for new booklet describing all Continental Mills Plastic piping, tubing and fittings.

PETROLEUM — Here's the ideal pipe for refinery discharge, crude oil, sour crude, salt water and natural gas.

UTILITIES — Easily installed in corroded gas lines by push- or pull-through methods. Eliminates trenching and repaving.

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A.P.I.—Integration

1. As long as fluctuations are continually occurring in the profit opportunities at the different levels of the industry, there is no question that an integrated company at any given time may make more money from one phase of its business than it does from another. Likewise it is inescapable that when one level of the industry passes into a period of unprofitability, such as the refining level did a short time ago, an integrated company may take losses on that activity and yet be sustained by profits made on other activities.

2. The underlying causes of the profit fluctuations and of the dissimilarities in them are deep-rooted in the economics of the oil industry and should be accepted as a natural part of business life and as a corollary of our system of private enterprise and open competition. Little could be done to remove them, and in all probability they would continue whether integrated companies were present in the industry or not.

3. All the available evidence indicates that vertical integration in the oil business has served largely as a means of gaining protection from the profit fluctuations and not as a device for precipitating those fluctuations and thereby working a hardship on the small, nonintegrated firm.

Nature of Investment Risks

A second important condition which has encouraged vertical integration may be found in the character of the risks associated with capital investments in the oil business. In many cases these risks are very large, and vertical integration has often constituted one important means by which the risks might be reduced.

The crude-oil and products pipelines provide an outstanding example. Many of the pipelines being built today have a cost ranging from $20,000,000 to $50,000,000 or higher. However, a pipeline is a highly specialized transportation facility. It is fixed with respect to geographic location and cannot be moved easily from one area to another in accordance with changes in traffic patterns as may an oil tanker or a truck.

It is entirely dependent for its existence upon shipments of crude oil or refined products and cannot draw business from a variety of different fields as may a railroad.

The number of customers from which a pipeline must obtain its main volume of business is also very small. Refiners are the principal shippers over both crude-oil and products pipelines, and the number of plants which may be located in a single geographic area at the terminus of a crude-oil trunk line or the originating point of a products line usually ranges between one and five.

In addition, pipelines are extremely vulnerable to reductions in volume of throughput because operating costs per barrel may rise as much as 40 per cent as the throughput falls from 100 per cent to 50 per cent of capacity.

Finally, it is important to note that the pipeline throughput ordinarily must be maintained over a fairly long period of years if the project is to be a financial success. Many of the pipelines operate under federal and state surveillance, and the regulations concerning tariffs and dividends payable to shipper-owners are such that payout periods are often as high as 15 to 25 years.

Because of these considerations pipeline investments are subject to substantial business risks, unless they are made by producing, refining, or marketing companies. Such companies are in a better position to make pipeline investments than are outside concerns for two reasons:

In the first place, for an integrated

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company the risks of a pipeline project are usually substantially less than they would be for an outside, independent concern. By controlling facilities at either or both ends of the line, an integrated company has greater assurance of continued traffic at a high level of throughput than could otherwise be obtained, except possibly by long-term contractual arrangements which would, in reality, constitute a special form of integration.

In the second place, an integrated company can often obtain greater rewards from the building of a pipeline than can an outside concern. An outside concern can obtain as profits only the difference between the pipeline tariffs and the pipeline operating costs.

However, an integrated company is in a position to obtain these profits plus whatever savings in transportation costs it may make by shipping its own traffic over the line rather than over a railroad or some other carrier. In many cases these savings in transportation costs are more important to a shipper-owner than are the pipeline earnings.

The physical facilities used in refining, producing, and marketing operations have in at least some degree the same general characteristics as do pipeline facilities. They frequently involve very large capital outlays, are highly specialized in terms of their economic utility, are extremely vulnerable to reductions in volume of throughput or output, and are heavily dependent for their competitive effectiveness upon supporting investments in other phases of the business.

As in the case of the crude-oil and products pipelines, vertical integration has often served to modify the business hazards to which these facilities are exposed.

Throughout the entire oil process, therefore, vertical integration has often provided a means of reducing risks and thereby of attracting capital funds to ventures which might otherwise have been very unattractive from an investment standpoint.

Opportunities for Cost Reduction

A third general condition favorable to the growth of integrated companies may be found in the fact that integration has often constituted a very important means of reducing costs.

It is here that the transportation function has played perhaps its most significant role in the growth of integration in the oil industry. Consider, for example, the cost situation of a company engaged in refining and marketing activities.

The company's refining expenses might run in the neighborhood of 50 to 60 cents per barrel, and management would have little opportunity to reduce those costs by more than 5 to 10 cents per barrel no matter how much attention it devoted to the problem. Similarly, the company's marketing expenses might average somewhere between 60 to 90 cents per barrel, and the most stringent economies would be unlikely to produce savings much greater than 10 to 20 cents per barrel.

However, in recent years the substitution of pipeline for rail transportation has often provided savings of 50 cents or more per barrel, depending on the length of haul. In other words, integration into pipeline transportation activities has constituted the single most important area in which a refining-marketing company could make gains vis-a-vis its competitors and improve its service to the public.

As a result, when particular geographic locations have developed a sufficient volume of business and other characteristics which permit the use of pipelines on an economical basis, the compulsions upon refining-marketing companies to build the lines have been very powerful indeed.

In many cases refining-marketing

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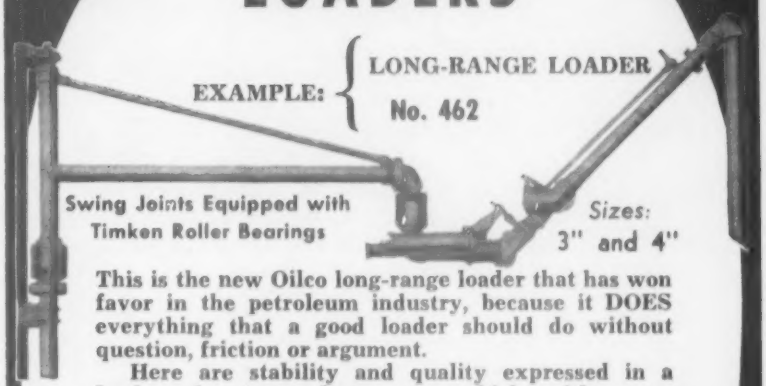

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companies have not been able to wait for outside interests to provide the necessary capital and to develop the required transportation service, but have been forced to build the lines themselves in order to obtain the facilities necessary to protect or enhance their competitive positions.

Moreover, as we have already observed, the balance of risks vs. rewards in the building of pipelines is often more favorable for a producing, refining, or marketing company than for an outside concern. As a result, integration by such companies into pipeline operations has occasionally constituted a means of building lines which would not otherwise have been built and of obtaining transportation-cost savings which would not otherwise have been available to the industry and to the public.

The opportunities for cost reduction arising from integration into pipeline operations have by no means, however, been limited to transportation savings alone. In addition, the building of products pipelines has often enabled individual refineries to enlarge the geographic areas which they could serve on a competitive basis. As a result, the industry as a whole has been able to reduce the number and increase the average size of its plants.

Between 1941 and 1953, for example, the number of refineries in the industry decreased from 556 to 343, and the average plant size increased from 8,487 to 22,270 bbl. per day. The larger plants, in turn, have permitted substantial savings in refinery processing costs.

The exact amount of these savings is difficult to measure, but some idea of their magnitude may be obtained from the fact that over-all processing costs per barrel may decline as much as 30 per cent as the size of a plant increases from 10,000 to 30,000 bbl. per day, assuming that all things other than size are equal.

Character of Managerial Job

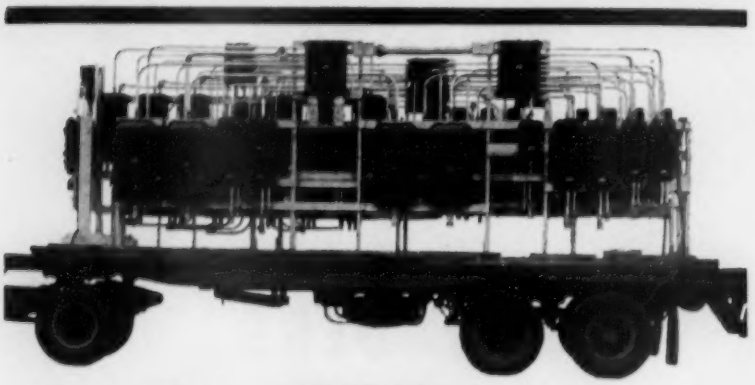
A fourth condition favorable to integration may be found in the character of the managerial job involved in planning and conducting the industry's affairs. The nature of the managerial job has been such that important benefits have been available to the companies which have been successful in developing integrated structures, together with sound techniques for administering their affairs on an integrated basis.

In an integrated company management has the opportunity to plan capital investments on a coordinated basis and to make sure that investments made in one part of the business are properly correlated timewise, placewise, and sizewise with respect to investments made in other parts of the business. Vertical integration thus has often enabled a company to do a more effective job in directing the flow of capital funds into the business.

Integration has offered similar advantages with respect to the logistical problems associated with the producing, refining, and distribution processes. The management of an integrated company is in a position to have intimate knowledge of activities at all levels of the business and can thus often do a better job of adjusting operations to meet the constant changes in market conditions than would be possible in a nonintegrated situation.

These managerial gains which are accessible to integrated companies usually become manifest over fairly long periods of time and are often difficult to demonstrate in concrete terms. The situation may be likened to a chess game in which the white pieces are all under the control of a single player, whereas the black pieces are moved by four or five different players, each of whom moves his particular pieces without too much knowledge of what his teammates are doing.

In such a game the white player



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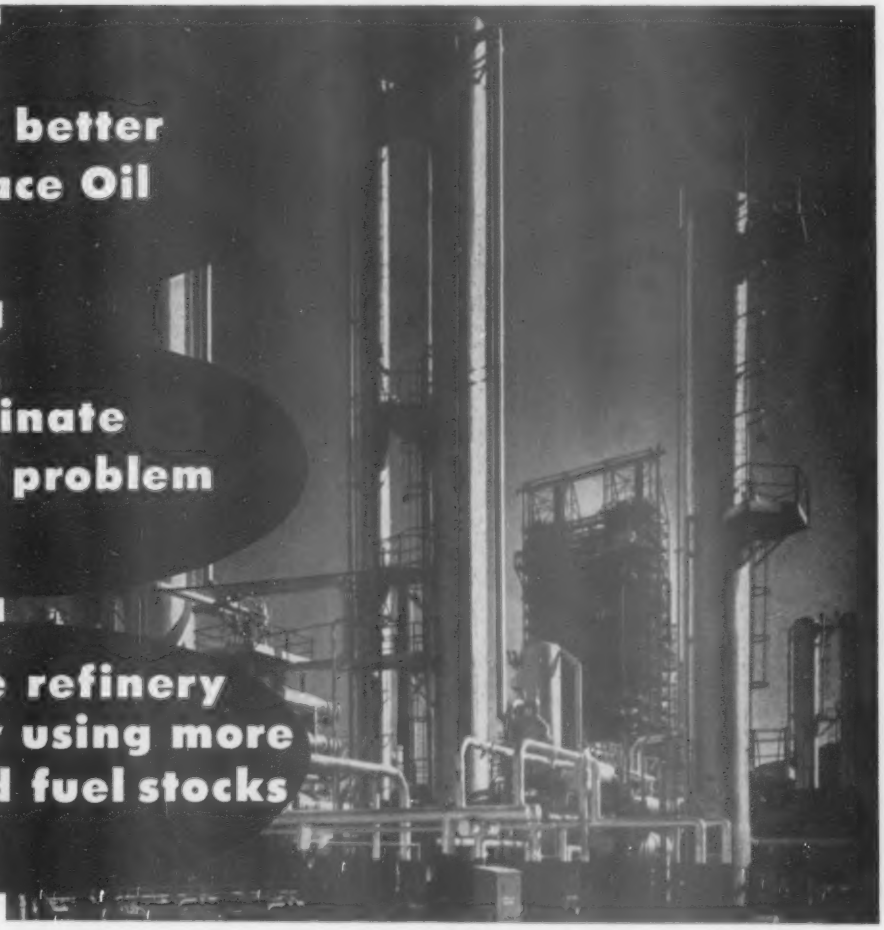

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would usually win through the development of a superior over-all strategy and the better utilization of each individual piece under his command, but it would be difficult to explain precisely how he was able to gain his advantage over the black players. So, too, an integrated oil company is often able to improve its over-all strategy in the employment of its capital and the conduct of its business, although the exact means by which the final result is accomplished is sometimes difficult to demonstrate.

As the affairs of the oil industry increase in scope, diversity, and complexity, there is reason to believe that these managerial gains permitted by vertical integration may become increasingly significant and may serve: (1) as an extremely important source of competitive and economic strength for the individual firm; and, (2) as a means by which the utilization of capital funds and efficiency of operations throughout the entire industry may be improved.

These four general conditions are by no means the only circumstances which have tended to produce an economic climate favorable to integration in the oil industry. In addition, there have been many temporary events which have provided strong stimuli to the integration process during limited periods of time.

Examples of these are the great crude-oil surpluses of the early 1930's which prompted many producers to integrate forward to obtain outlets for their products and the severe shortages of crude oil and refined products immediately after World War II which prompted both refiners and marketers to integrate backward as a means of assuring and protecting their sources of supply.

The extensive growth of integrated companies must also be attributed, in part, to the fact that the industry has been reasonably free from serious obstacles to integration. Many examples may be found of other industries in which the business and economic reasons for vertical integration have been almost as persistent and powerful as in the oil industry, but in which relatively little vertical integration has ever taken place.

Examination of these other industries reveals that they have usually been characterized by major obstacles to integration which have not been present in equal degree in the oil industry. Examples are the problems of fashions and styles and the use of multiproduct facilities for transportation and distribution purposes which, along with many other things, have restrained integration in both the furniture and textile industries.

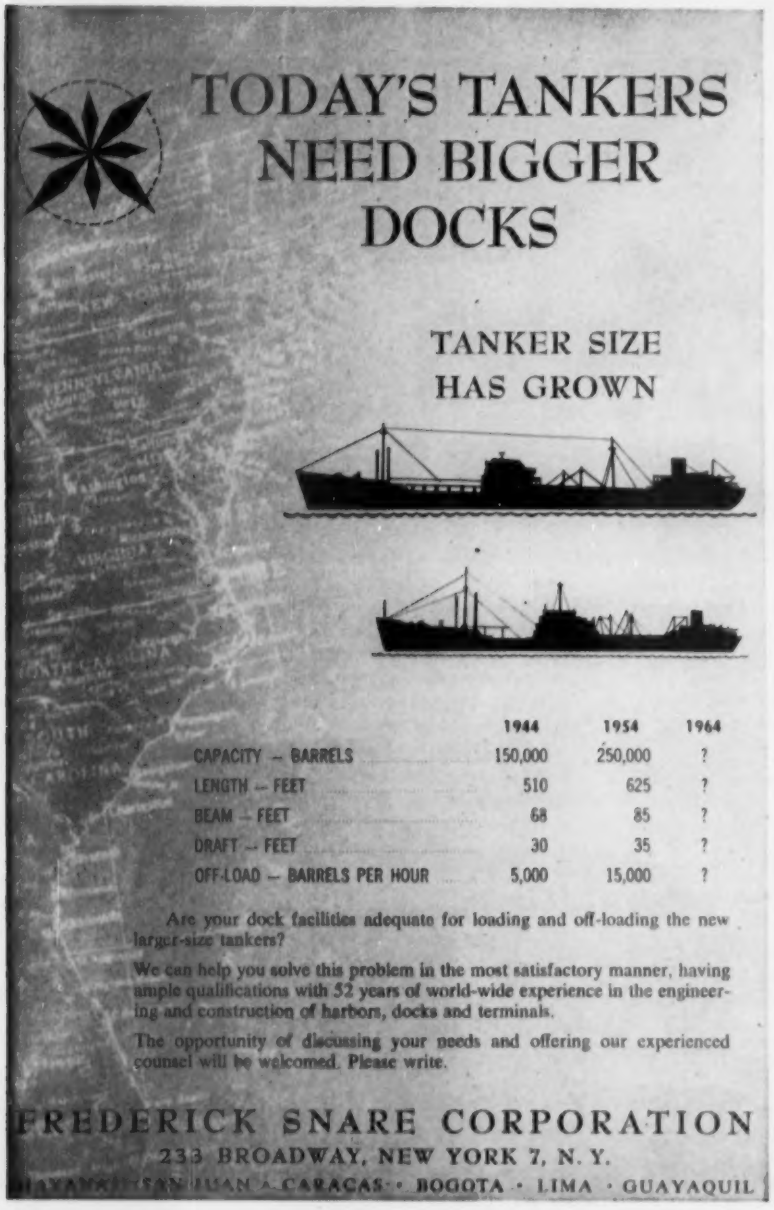
Therefore, it appears that extensive integration has occurred in the oil industry, not only because there have been good reasons for it, but likewise because there have been relatively few serious obstacles to it.

How Companies Integrate

In the presence of favorable conditions, both general and temporary, and in the absence of serious obstacles, vertically integrated companies have grown in the oil industry by a process of progressive adaptation much like the process of evolution which is continually going on in the world of living things.

The process has been characterized by a high degree of individualism, and one may find in the industry today literally hundreds of different types of integrated companies which are vigorous, profitable, and able to compete effectively with each other. These many different forms which integration has taken reflect the ingenuity of management in finding a variety of successful solutions to the particular problems and hazards which oil operations have posed.

The process of integration has also been characterized by a great deal of experimentation and much trial and error. Few, if any, oil companies have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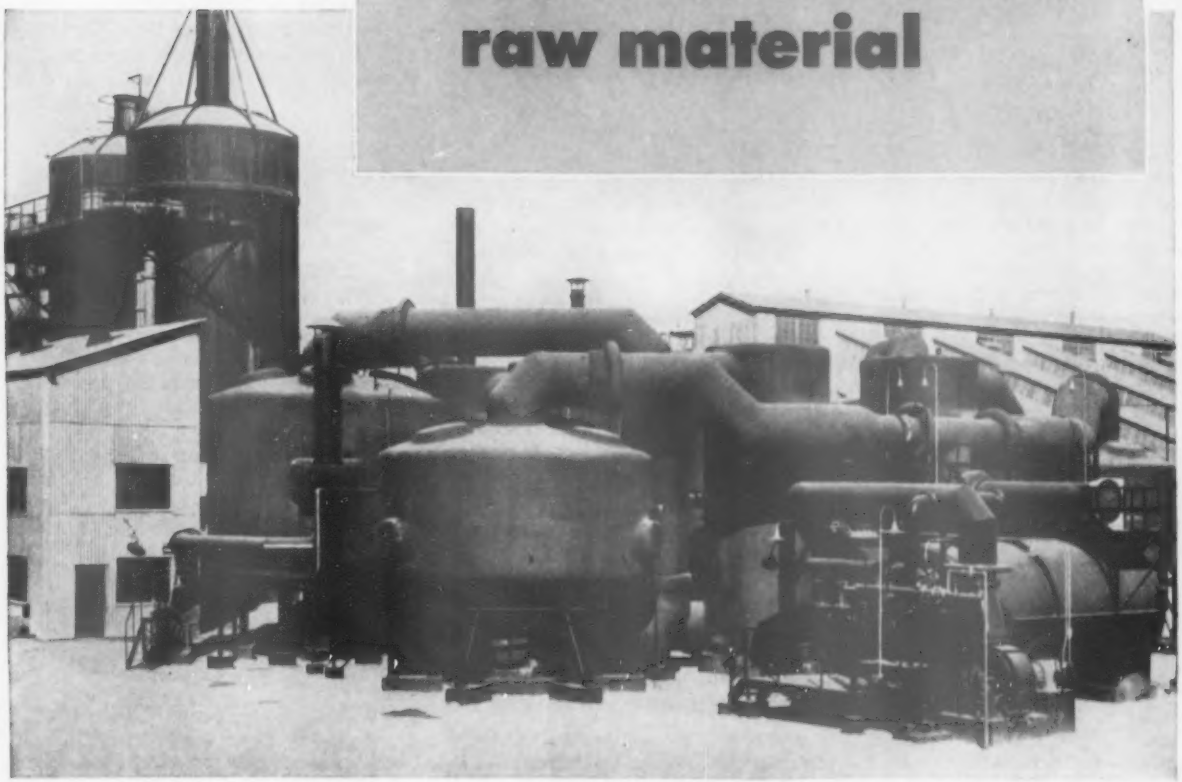

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retained precisely the same form of integration for any very long period of time.

They have been continually developing new integration arrangements to meet the requirements of new situations, and they have often abandoned particular types of integration when experience has indicated that the job could be done more effectively by nonintegrated concerns.

Rarely, if ever, has the process of integration in the oil industry been carried to completion. I know of no oil company which has been fully integrated at any time in its history in the sense that it produced all its own crude oil, manufactured all its own refined products, owned and operated all its own transportation facilities, and carried all its output to customers exclusively through its own bulk plants and service stations.

On the contrary, the structures of most oil companies have been out of balance at many points and, therefore, have provided an opportunity and a need for the companies to enter into purchase, sale, or exchange arrangements with nonintegrated companies or other integrated companies having a different balance of operations.

The process of integration in the oil industry has been carried out in such a manner that it has not destroyed the opportunities for small, nonintegrated companies. In many instances nonintegrated companies fill out the gaps in the structures of the large, integrated concerns, and the integrated and nonintegrated firms thus play supplementary roles in conducting the industry's affairs.

In addition, there are many phases of the industry's operations where the economic conditions and business risks have favored the growth of small, nonintegrated concerns and where such firms have been able to compete on equal or better than equal terms with the large, integrated companies.

Finally, it is important to recognize that the process of integration in the oil industry has often been used to intensify the pressure of competition. Many integration actions, particularly in the field of transportation, have been initiated to cut costs and to gain access to new business. An excellent example is the bypassing of bulk plants with truck transport deliveries to service stations. Conversely, many integration actions have been initiated as a last resort to protect a company's business from capture by newcomers who have found a cheaper means of reaching the market.

Integration should be viewed, therefore, not as a threat to competition, but as one very important aspect of competition. Like any other form of competition it may sometimes have been used unfairly and may occasionally have worked an improper hardship on the small, nonintegrated firm. On the whole, however, it has usually been one of the most constructive forms of competition because, as we have observed in this discussion, it often serves to increase stability of earnings, to reduce business risks, to achieve cost reductions, and to improve managerial efficiency.

Conclusion

From the standpoint of the individual company, it seems to me that our findings suggest two things:

1. A company management should never be content with whatever integration arrangements the company may have today. If it is indeed true that integration is largely a matter of progressive adaptation to economic realities, it follows that new integration arrangements will be continually necessary as the conditions of the industry change.

Therefore, strong emphasis should be placed upon constant experimentation with new and different arrangements, and integration policies which remain static for any very long period of time should be subjected to rigorous reexamination by management.

2. It appears that company managements should direct increasing attention to the managerial gains which can be obtained through integration.

Several of the companies we studied made this comment: "In terms of physical facilities we have been integrated for a very long time, but it is only recently that we have begun to manage on an integrated basis."

From the standpoint of oil-industry programs our findings likewise suggest two conclusions:

1. The industry should continue to assemble and release detailed facts about how the industry and particular companies in it have grown and developed. Some of them will unquestionably reflect unfavorably upon the industry because this industry like all others has its seamy side.

However, it is our firm belief that the facts, taken in total, will bear more eloquent witness than any other possible argument concerning the intensity of competition in the industry and the true character of the circumstances which have prompted the growth of the various types and sizes of companies found in the industry today.

2. Our findings suggest that the industry should never advocate legislation or other programs which are designed to guarantee the continued existence of large companies, small companies, integrated companies, or nonintegrated companies.

These opportunities should be expected to undergo change as new economic, technological, or managerial circumstances arise. Therefore, the concerted action of the industry should be directed toward maintaining for all companies the freedom to adapt the size and structure of their organizations to the particular conditions prevailing in the functional and geographical areas of the industry in which they have chosen to operate.

Finally, from the standpoint of our national policies, our findings suggest that we should proceed with the utmost caution in placing any restraints on the types of integration which oil companies may undertake, for two reasons, viz.: (1) because by so doing we may interfere with the processes of business evolution and thereby preclude the development of new forms of organization which would be ideally suited to conditions of the future which none of us can now foresee; and, (2) because the managerial strategy which is exercised in the formulation of new and different integration programs represents an advanced and generally healthy form of competition, and we should be loath to place restraints upon it.

More on A.P.I. Meeting Papers

Turn to page 308 for additional reports on papers presented at the annual A.P.I. meeting. Activities of some of the more important A.P.I. research projects are summarized in a special section. Reports are included on Project 6—Analysis, Purification, and Properties of the Hydrocarbons; Project 42—High-Molecular-Weight Hydrocarbons in Petroleum; Project 44—Data on Hydrocarbons and Related Compounds; Project 45—Low-Molecular-Weight Hydrocarbons in Petroleum; Project 48—Sulfur Compounds in Petroleum; Project 50—Thermodynamic Properties of Hydrocarbons and Related Compounds; and Project 52—Nitrogen Compounds in Petroleum.

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Next page, how Westinghouse improves turbine efficiency . . . →

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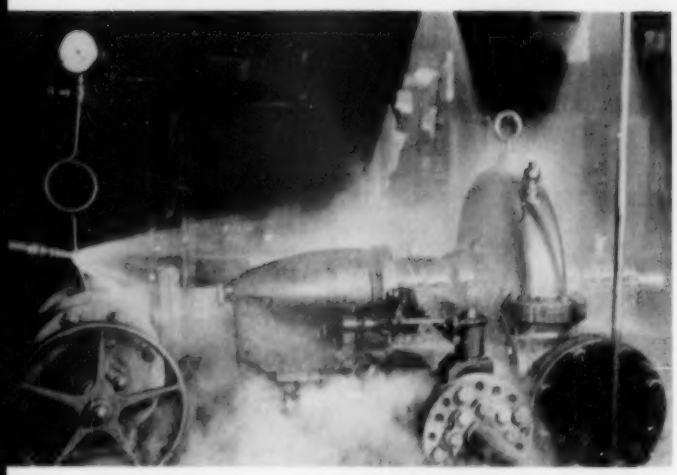
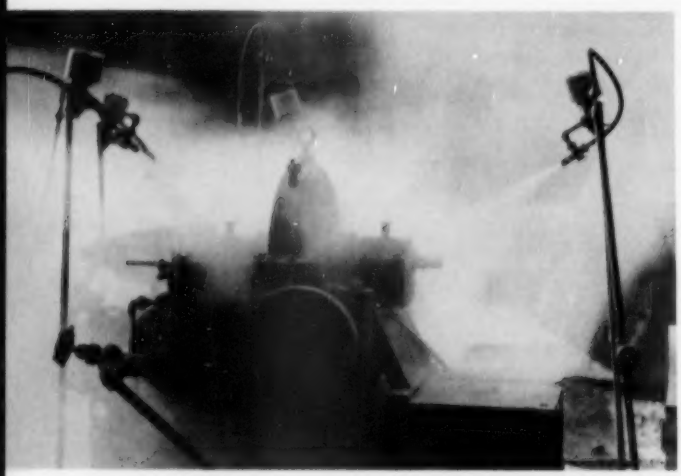


Water-test periods running for hours and hours, with turbines operating and standing still, prove the effectiveness of bearing seals against water contamination of the lubricating oil.



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Flexibility to satisfy each application is the key to both the low operating cost and reliability of Westinghouse general-purpose turbines. Here's how it is achieved. Variations in governor types, rotor and staging design are standardized for Westinghouse turbines. Interchangeability of these standard components allows Westinghouse engineers to custom-assemble each turbine. This interchangeability, plus Westinghouse complete line of turbines, multi-stage to single-stage, brings greater accuracy in meeting your particular steam conditions, range of speed control, steam consumption and type of service.

Low inventory investment

Spare parts inventory for differing turbine installations can tie up important capital. Standardization of Westinghouse turbine parts is an answer. Gland seals, bearings, valve parts and governor components have a wide degree of interchangeability. A minimum inventory then backs up many different Westinghouse turbine applications.

Dependability from precision manufacturing

Over 50 years of expanding turbine developments adds valuable experience and dependability to Westinghouse design and manufacturing methods. Only those developments proved through years of actual service have been standardized. Skill and precision developed in manufacturing these components result in mechanical strength and construction which stand up longer under the toughest operating conditions.

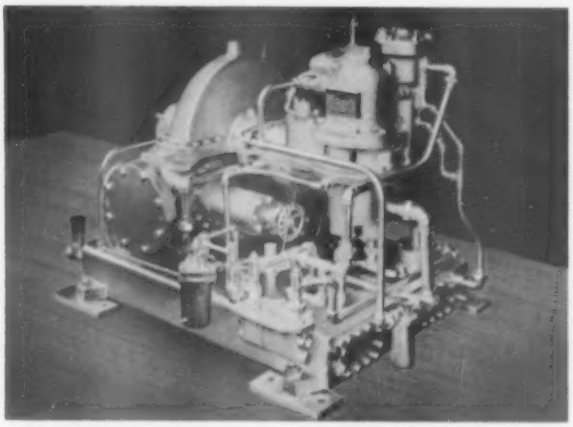
. . . Plus protection designed to "take it"

Watch Westinghouse turbines stand up under tough endurance testing and you have an answer to their ability to "take it". Positive protection results from corrosion-resisting alloys and ball and socket joints used on exposed governor mechanisms. There are no close-sliding fits to become corroded or jammed. Gland rings are mounted in corrosion-resisting inner casings. The rotor shaft, too, is protected at the gland zones by a generous, metal-sprayed coating of stainless steel.

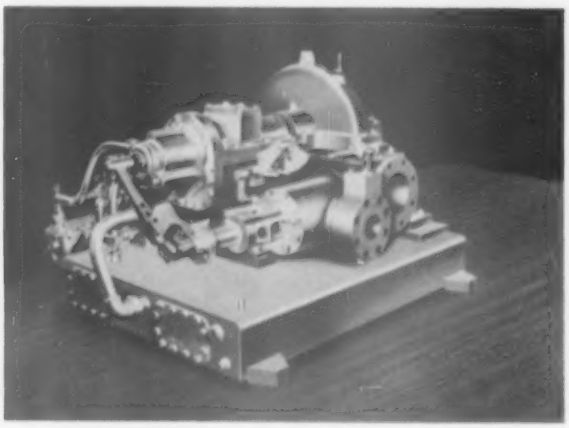
YOU CAN BE SURE...IF IT'S

Westinghouse

These standardized components for general-purpose, Type E turbines (5-1500 hp), are typical of the many parts that have a high degree of interchangeability between ratings. They allow Westinghouse to custom build each turbine for top operating economy. Mechanical governor shown gives accurate control and dual protection against overspeeding.

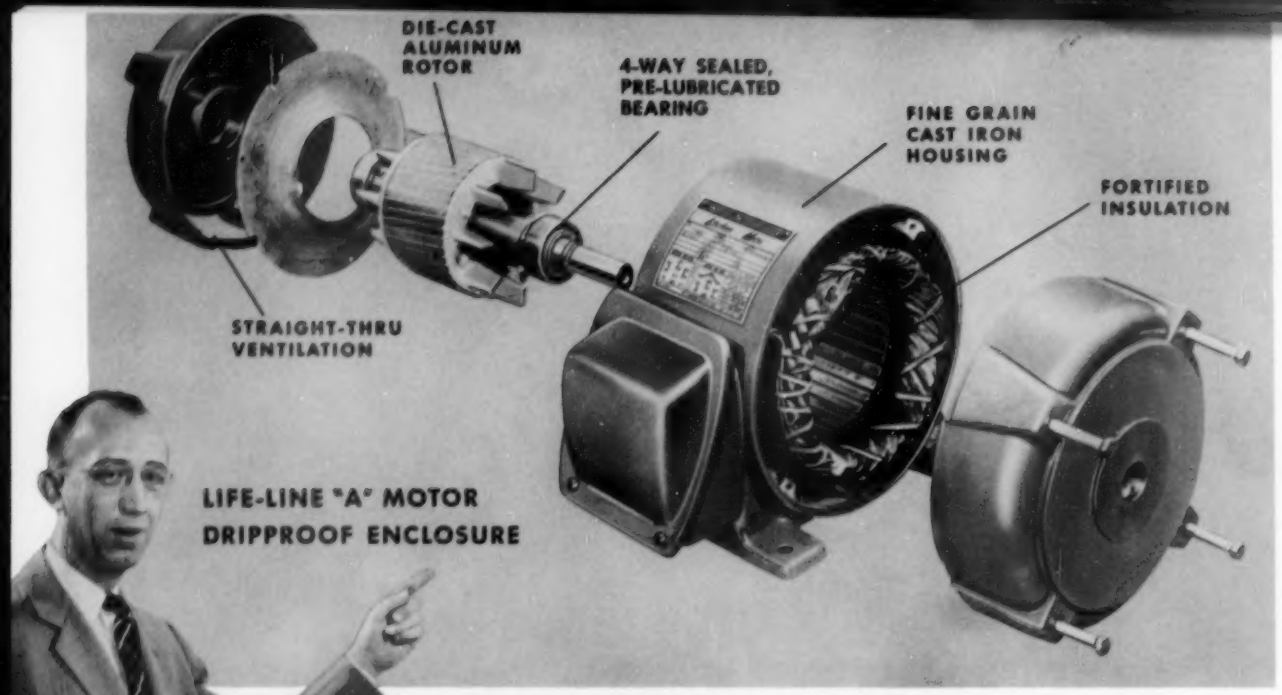


Here the Type E turbine rotor combines with the Westinghouse vertical oil relay governor to give the maximum in precise governing. The exclusive oil reservoir bedplate means quicker installation, simplified alignment, neater appearance.



This Type E turbine with the Westinghouse hydraulic orifice governor provides a wide speed range for drive applications such as fans and blowers. This is a direct-acting oil governor with hand speed changer for 3-1 speed adjustment.

Next page, an answer for electric drive flexibility . . .



PLANNING MOTOR DRIVES:

New Life-Line "A" protection and stamina offer greater application flexibility

Improvements in the new Life-Line® "A" motor line will answer your questions about adequate motor protection for refinery drives.

Compare enclosures for instance. In hazardous areas you naturally require the protection of the Life-Line "A" totally-enclosed, fan-cooled motor. And in those cases where you normally use a drip-proof motor the Life-Line "A" offers an improved enclosure of fine-grained cast iron. The straight-through ventilation design assures complete drip-proof protection *regardless of mounting position.*

Improvements on the inside broaden the application flexibility of the drip-proof motor. Bondite stator insulation is fortified with silicone in homogeneous suspension with the insulation varnish affording unusual protection against chemical and water vapors plus improved stability for longer life. Four-way sealed, pre-lubricated Life-Line "A" bearings prevent dirt or moisture entering the bearing. They eliminate, too, the cost and time of greasing maintenance.

Talk further with Westinghouse application engineers about your horsepower requirements. They'll help you select from a complete line of Life-Line "A" and Westinghouse synchronous motors.

MP-3035

YOU CAN BE **SURE**... IF IT'S

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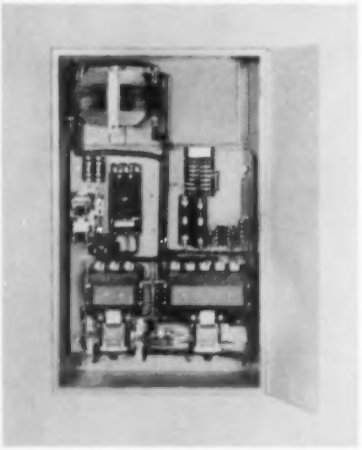

Add-a-part Panel for Westinghouse reduced-voltage starters provides maximum flexibility for process drive control. The panel is factory drilled with plenty of free-board area for on-the-spot mounting of additional timing, relaying or other control devices as required.

WHEN CAN WE START ON YOUR DRIVE PROBLEM?

Whether you're planning steam, electric or both types of drive, call your local Westinghouse sales engineer. He's ready with complete engineering and service facilities to give you immediate help. Ask him, too, for any of the following literature or write Westinghouse Electric Corporation, 3 Gateway Center, P.O. Box 868, Pittsburgh 30, Pa.

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Life-Line Gearmotors	B-5645
Speed Reducers	B-5646
Complete Industrial Control	B-6051
Life-Line Starter	B-5882
AB-I Circuit Breaker	B-5456
Synchronous Motors and Control	B-5300
Life-Line Motors (200-700 hp)	B-4731
Large Induction Motors	B-4739
Preventive Maintenance Booklet	B-5477
Type E Turbines	B-3896
Type M Turbines	B-3442

AMPLE VENTILATION PLUS a safety-alarm system gives double protection to personnel working in this building. The alarm system (above, right) flashes a light and rings a bell every 15 minutes and continues each time until the technician comes outside to shut it off.

Great Southern designed this building especially . . .

For safer aromatics blending

IN constructing its laboratory blending and sampling building for aromatics, at Corpus Christi, Tex., Great Southern Chemical Corp. not only provided ample ventilation but also installed an alarm system that strictly limits the time during which laboratory personnel are exposed to aromatic fumes.

The building is divided into a sample storage room and a blending room, with connection between the rooms through two sets of insulated metal swing doors. These sets of doors, together with the short passageway between them, form a small anteroom extending out into the sample storage room. This arrangement helps to minimize entrance of warm air into the blending room each time someone leaves or enters.

Safety feature . . . The alarm system mounted outside on the front of the building consists of a horn and three lights. A white light is used as a current indicator to show that the safety circuits are energized. A blue light is turned on by an adjacent switch which also turns on the lights inside the blending room and activates a time-delay switch set for 15 minutes. The lab technician may then enter the building and work in the blending room for the 15-minute period.

After this period the time-delay switch acts to turn on a red light and cause the horn to blow outside while a bell is sounded inside the blending room. In order to turn off the red light and alarms, the operator must leave the building and walk to the rear where the reset switch is located. By pressing this he reactivates the time-delay system and is free to return and work another 15 minutes until the alarms sound again.

It is felt that the length of time required by the lab man to reset the switch is sufficient to clear his lungs and nasal passages of any deleterious aromatic vapors. Only one man is permitted to work in the blending room at a given time. If for any reason he should lose consciousness during the 15-minute period inside the blend room, he would still be protected by the alarm system. Since the audio and visual alarms are mounted outside, plant and lab personnel will investigate if these are not reset in a reasonable time.

For additional employe protection, a plastic skylight has been installed in the form of a dome over the sample storage room. In the event of an explosion the force of the explosion will be dissipated largely by blowing out the dome, thereby minimizing effects of the explosion within the structure.

Ample ventilation . . . The blend room is equipped with an exhaust fan and automatically operated louvers. The fan provides an air change every 3 minutes. Initially, two louvered windows were installed on the north and south sides to provide cross-ventilation. In addition two bottom rows of the hollow concrete blocks used to construct the building and a row near the top in each wall have been laid at right angles to provide ventilation holes. This minimizes possibility of accumulation of fumes near the floor or ceiling of the blend room.

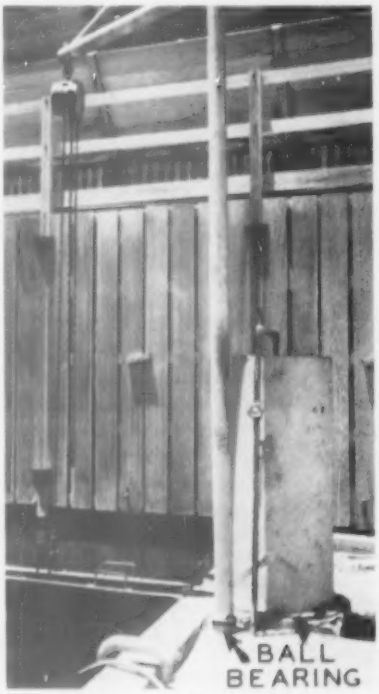
The blending room is refrigerated by a 20-ton unit to hold the room at between 34° and 40° F. This low temperature level permits a stable aromatic blend to be made. The room is insulated on the inside with a thick cork layer covered by insulating paper. A deep-freeze cabinet for holding samples is included, along with other laboratory installations and equipment. This blending and storage building was designed and built under the supervision of F. G. Heater, chief engineer.

Dual screens make cleaning easier

A DUAL-SCREEN arrangement at the pump intake of the cooling tower permits frequent cleaning of the screens yet still insures that no foreign matter will be taken in by the suction of the pump at Trinity Gas Corp.'s cycling plant in Sejite field, South Texas.

Under light operating conditions, the chlorinator can usually handle most forms of organic matter. However, there are often times when dead algae and dead wood could clog the screen on the tower side of the intake pond, causing a differential across the pond.

When this occurs, a permanent gin pole and block are used to raise the clogged screens and swing them in



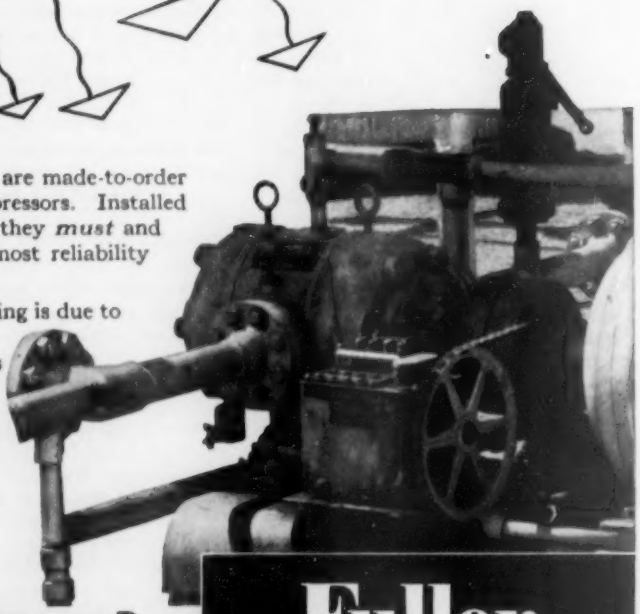
TO MOVE THE SCREENS from intake pond to bank, a block and tackle is hung from a gin pole set in a ball-bearing mounting.

ALL BY ITSELF!

Gas gathering and booster service are made-to-order applications for Fuller Rotary Compressors. Installed at far-flung, out-of-the-way well heads, they *must* and *do* operate for long periods with the utmost reliability and with the very minimum of attention.

That they can be relied on to keep the gas flowing is due to the simple rotary design and rugged construction, a minimum of moving parts—rotor, blades and bearings—and the incredibly smooth, vibrationless operation.

Hundreds of installations throughout the oil fields attest to the high standard of performance set by these Rotaries—ample assurance of what you can expect when you specify Fuller.



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from the pond by pivoting the gin pole in its ball-bearing mounting. The screens are then quickly cleaned with a steam hose, and reset in the pond. In the meantime, the second set of screens is still in place to perform the necessary straining of the water.

The cleaning operation can be performed so conveniently that it is done as a routine task. Plant superintendent for Trinity is J. O. Jones.

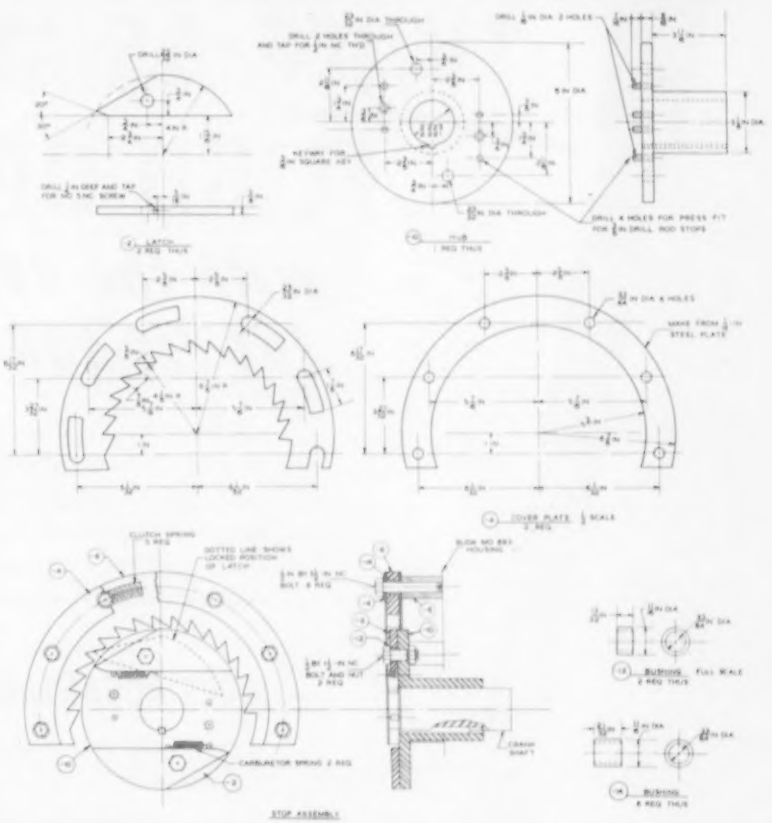
Pipe dolly aids threading work

THIS dolly is used to support pipe being threaded in a power-driven unit at La Gloria Corp.'s cycling and gasoline plant at Falfurrias, Tex.

The dolly, which rides on a track made of two lengths of 1-in. scrap pipe, is made of 1-in. pipe supporting a platform which in turn supports two roller bearings mounted in a stand.

The pipe being threaded rests on these bearings, which allow it to rotate freely as it is being threaded in the power unit. The roller-bearing mounting is welded to a threaded rod supported by a nut welded in the center of the dolly platform. This threaded rod may be adjusted to support different sizes of pipe on a level with the pipe-threading unit.

MADE OF SCRAP MATERIALS, this dolly moves up and back on a track of discarded pipe to accommodate any length of new pipe ready for threading.



CONSTRUCTION DETAILS of reverse-rotation arrestor for industrial engines. All parts may be made from S.A.E. 1020 cold-roll steel.

Here's how Phillips designed a device for . . .

Arresting reverse rotation

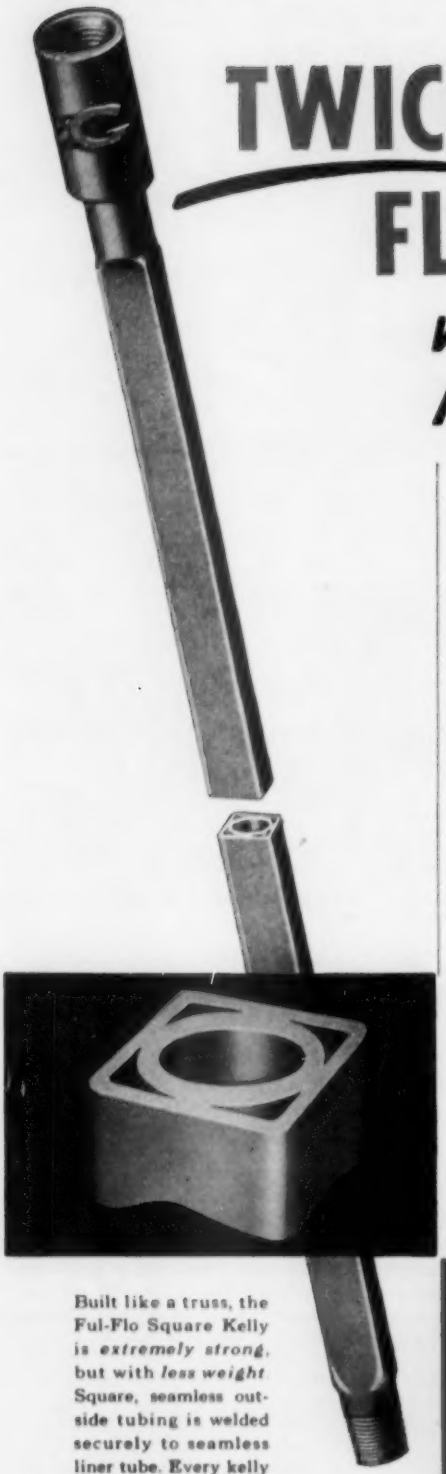
INDUSTRIAL engines used to drive the water-circulating pumps at the Edmond plant of Phillips Petroleum Co.'s natural-gasoline department formerly were subject to damage caused by reverse rotation when the engines went down unexpectedly. Even with careful maintenance, the discharge check valves leaked enough to allow water to flow back through the pump and turn the pump and engine backwards. Operation of the engine in reverse will burn up the crankshaft, rod bearings, and main bearings in 5 minutes due to lack of lubrication.

Installation of the reverse-rotation arrestor (see drawing) has prevented the engine from reversing even under adverse test conditions. The arrestor is also designed to prevent damage to the engine from backfiring. Suggested by W. J. Turner and J. C. Cole.

Hot-oil air cleaner

WHEN changing between product grades at the refinery barrel-filling station it has long been the practice to blow the line clear of the grade previously handled. Low-pressure air previously used for this purpose resulted in insufficient clearing of lines. Between 100 and 150 gal. of oil often had to be slopped because of contamination.

A considerable decrease in slop oil was achieved by installation of an air heater and the use of higher pressure (100 psig.) air. High-pressure heated air has been doing a most effective job in clearing the lines. Method was suggested by Basil A. Dutton, helper; courtesy Humble Oil & Refining Co., Baytown, Tex.



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- Less wear—passes easily through the packing rubber.
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- Greater stability and perfect balance reduce wear on related drilling equipment.

Built like a truss, the Ful-Flo Square Kelly is *extremely strong*, but with *less weight* Square, seamless outside tubing is welded securely to seamless liner tube. Every kelly is tested at 3,000 PSI.

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V-Belt Drives for Slush Pumps—4

by William S. Worley

FIG. 1 compares the ratings for a premium-quality D-section belt with those for a standard-quality D-section belt, both at 900 r.p.m. It illustrates the approximately 40 per cent higher ratings of the premium belts. The rig designer can take advantage of these higher ratings either to reduce the number of grooves required on the pump sheave and the driver sheave, or to adapt an existing drive to a larger pump. The user, of course, can also take advantage of the higher ratings for premium belts in a similar fashion.

Fig. 2 which compares premium D ratings at 700 r.p.m. and at 900 r.p.m., suggests another interesting design possibility. For example, let us take 21-in. pitch diameter driver sheave at 900 r.p.m. A premium belt is rated at approximately 48 hp. If one could make a reduction in the draw works from 900 to 700 r.p.m. —and if the clutch could be designed to handle the correspondingly higher torque—then, with the same size pump sheave, we would use a 27-in. sheave as driver. This would give the same pump speeds as the original 21-in. sheave at 900 r.p.m., but the horsepower rating is now almost 55 hp. per belt, an increase of 12 per cent.

While the E cross-section ratings are higher than those for D section on a belt-for-belt basis, the ratings on a horsepower per inch of face-width basis are higher for the D section at the smaller diameters. Fig. 3-A shows the comparison between a D and an E-section drive for the same total rating on an 18-in. diameter sheave at 900 r.p.m. Fig. 3-B shows the same picture on a 22.8-in. diameter sheave at 700 r.p.m.

A graphical summary of the rating picture is given in Fig. 4. Four drives of the same approximate total horsepower rating are shown. The first, with 20 D-standard belts represents current drives; the next, with 14 premium belts, the space and belt savings possible by direct substitution of premium belts for standard belts. The third illustrates the further reduction in space and belts available by reducing the driver-sheave speed from 900 to 700 r.p.m.; and simultaneously increasing the driver diameter from 21 to 27-in. The fourth, of course, represents the fewer belts required when E-section premium belts are used on the 27-in. pitch diameter sheave at 700 r.p.m.

The ratings presented here have been specifically developed for use in designing slush-pump drives. We have outlined above the assumptions underlying these ratings. One of the assumptions is that average service life need be only 10,000 hours to give drives which are satisfactory for the service for which the belts will be used. This assumption we believe to be valid for slush-pump service. But this assumption is not valid for all V-belt drives used by the petroleum industry. Drives for pumping units, pipeline pumps, repressuring compressors, and similar applications are required to give long industrial-type service. These ratings, therefore, should be used only for V-belt drives intended for slush-pump service.

New horsepower ratings for V-belts used in industrial service, of which pipeline pumping or repressuring service would be typical, have been adopted by the Rubber Manufacturers Association and the Multiple V-Belt Drive and Power Transmission Association. A joint engineering standard incorporating the new ratings is in preparation, and will soon be available. The new ratings are also to be found in the published design manuals of the V-belt manufacturers. These ratings should be used generally for all V-belt drives except those for slush-pump service—although, of course, V-belt engineers will always be ready to give recommendations and suggestions on drives intended for specific limited-service problems.

Author is with Gates Rubber Co., Denver.

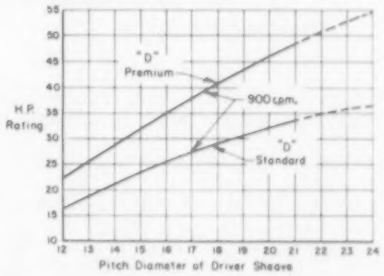

Fig. 1—A comparison at 900 r.p.m. of premium quality and standard quality "D" section V-belts.

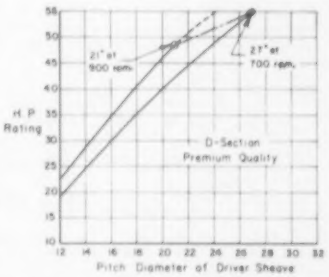

Fig. 2—A comparison of premium quality "D" section V-belts at 700 and 900 r.p.m.

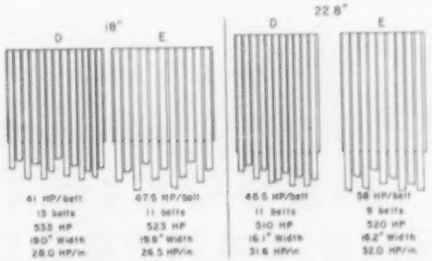

Fig. 3—A comparison of "D" and "E" section V-belt drive for a like rating.

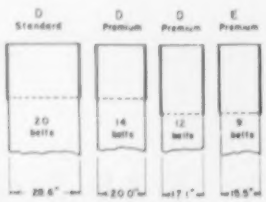

Fig. 4—These four drives are of the same approximate total horsepower rating.

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by
Harold Woodhouse

Series vs. Parallel Arrangement of Centrifugals for Gas Pipeline Stations—2

A SIMPLE case of two centrifugals in parallel working against a constant discharge pressure as is required for pipeline application is shown by Fig. 2.

The possible range of suction pressures from minimum to maximum capacity for speeds ranging from 80 to 110 per cent of normal speed is shown by the dotted envelope for compressor A. A similar performance envelope is shown for compressor B.

The possible range of operation for the two in parallel is shown by the heavy envelope. For the considered application their combined operation would always be restricted to some point on that portion of the pipeline characteristic lying within the combined-operation envelope. It will also be noted that the combined performance will always be equal to or less than the maximum-pressure ratio which compressor A can develop at the speed at which it is running—for simplicity we are assuming that both compressors vary their speeds in unison.

The reason for this is that since compressor A develops a smaller pressure ratio than B, it could not develop a greater pressure ratio than P_2/P_s at 80 per cent speed or P_2/P_{s1} at 110 per cent speed, whereas compressor B could.

Therefore, if A were called on to supply a greater pressure ratio than possible for it and this pressure ratio were less than B's maximum, then B could maintain discharge pressure but A could not. Then the gas from B would tend to feed back into the discharge of A. Actually the check valves would prevent this from happening, but A would stop delivering and have to be shut down.

It will also be noticed, if we consider the combined compressors as delivering their maximum flow to the pipeline at 110 per cent speed, that the total flow is made up of A M.M.s.c.f.d. from compressor A and B M.M.s.c.f.d. from compressor B. Since the pressure ratios are the same, this means that the compressors will require different horsepowers. For the compressors illustrated, this horsepower difference will occur at all points of operation other than the design point—assuming that their efficiencies are the same at the design point.

It will be seen then that since differences in pressure ratio and delivered flow are not desirable when the compressors are operating under identical suction conditions, the head-capacity characteristic curves should be as much alike as possible.

When centrifugal pumps or compressors are to be operated in parallel, it is desirable that each have a steep head-capacity characteristic curve to minimize the surging which might take place between them under conditions of varying load.

Referring to Fig. 3, typical head-capacity characteristics are presented in the standard manner for constant-suction pressure and variable-discharge pressure. Curve 1 would be considered a steep one whereas Curve 2 is flat. Plotting these to pipeline application of constant-discharge pressure and variable suction, we have compressor characteristic curves as shown in Fig. 4.

Author is chief engineer, Dean Hill Pump Co., and consultant on compressor design.

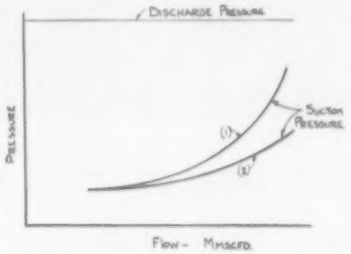

Fig. 2—Two centrifugals in parallel working against a constant discharge pressure.

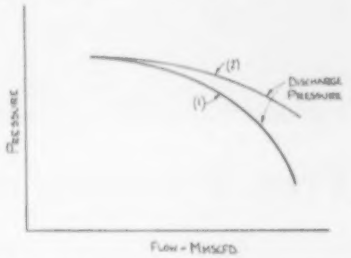

Fig. 3—Typical head-capacity characteristics for constant suction pressure and variable discharge pressure.

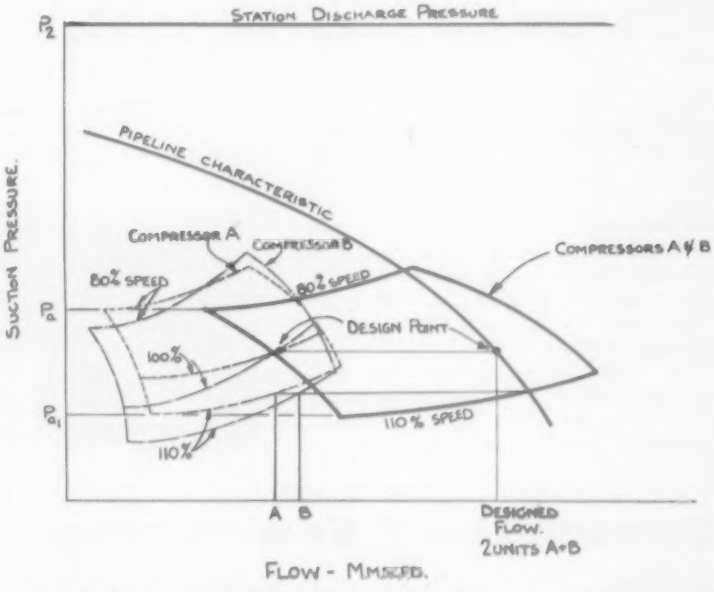

Fig. 4—Plot of head-capacity characteristics to pipeline applications of tungsten-discharge pressure and variable suction.

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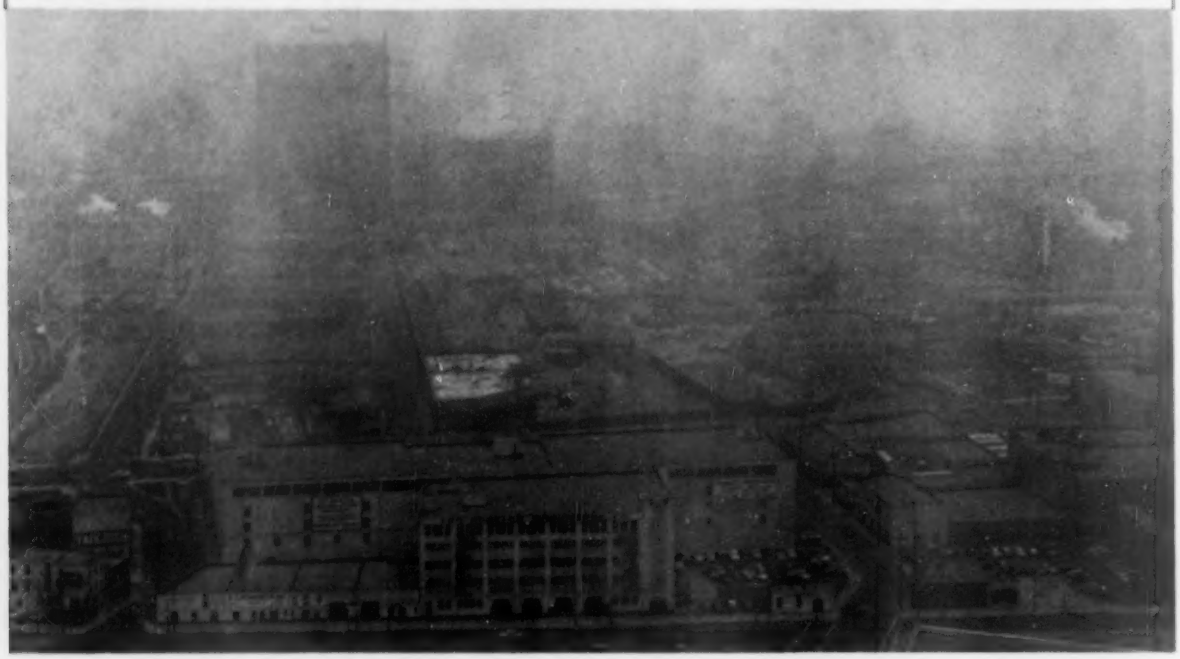

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If you are faced with the problem of keeping your community's atmosphere breathable . . . or the problem of controlling an industrial process where sulfur compounds are an important factor, contact Consolidated Engineering. One of our Field Engineers will be pleased to show what the Titrilog can do for you. Write for Bulletin CEC 1810C-X2.

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Applying Spectroscopy in Petroleum Analysis—4

by R. C. Pomatti, R. F. Meeker, and Harry Levin

WHAT is the basis for emission spectroscopic analysis? Briefly, it is the fact that atoms of every element brought to an incandescent or excited state emit radiation of various wave lengths which are characteristic of that element. An electric arc or spark is generally used to excite the atoms. The radiation is then sorted by an instrument called a spectrograph which uses a prism or a diffraction grating as the actual "sorter" or dispersing medium. (Fig. 9 is a schematic drawing of a prism instrument). A photographic emulsion or photoelectric cell detects the radiation of various wave lengths entering the spectrograph through a narrow slit. On a photographic plate or film the result is a series of short vertical lines, actually images of the slit.

Authors are with The Texas Co., Beacon Laboratories, Beacon, N. Y.

Fig. 10 shows several idealized emission spectra. Actually there are many more lines; these only show some of the stronger ones. Below each sample spectrum is an iron spectrum, obtained by arcing two iron rods, which serves as a yardstick or reference scale to aid in the qualitative interpretation of spectra. One becomes familiar with the locations of the main lines of each element with respect to this iron spectrum.

The basis for quantitative emission analysis is the fact that the radiation intensity of a particular element is dependent primarily on the number of atoms of that element in the sample. With a greater concentration of atoms, the lines on the photographic plate become blacker. At present, quantitative analysis is conducted on an empirical basis for which known standards, somewhat similar to the sample, are necessary. Standards and unknowns are exposed under as nearly identical conditions as possible.

The density or opaqueness of the lines used in the analysis is obtained as per cent transmission with a densitometer employing a photoelectric cell. Fig. 11 shows a portion of a typical quantitative plate obtained in the analysis of oils. It contains a set of standards and several unknowns. Note how the lines of silicon, aluminum, and iron become darker as their concentration increase in the standards. The densities of the analytical lines of the standards are plotted versus concentration on graph paper and the resultant analytical curve is used to analyze unknown samples. (Fig. 12 shows a typical analytical curve).

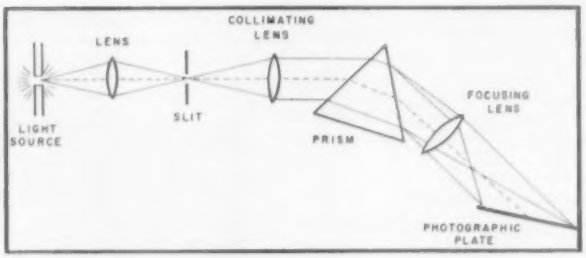


Fig. 9—Optical diagram of a prism spectrograph.

Fig. 11—Portion of a typical quantitive plate obtained in the analysis of oils by spectroscope.

Fig. 10—Typical emission spectra.

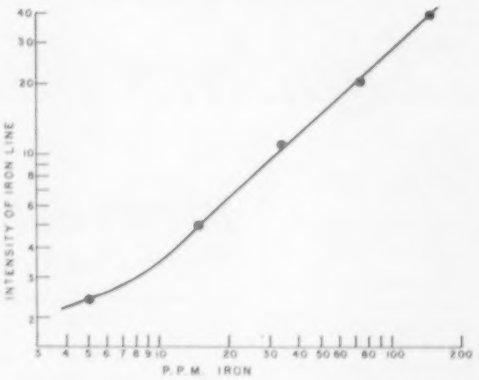
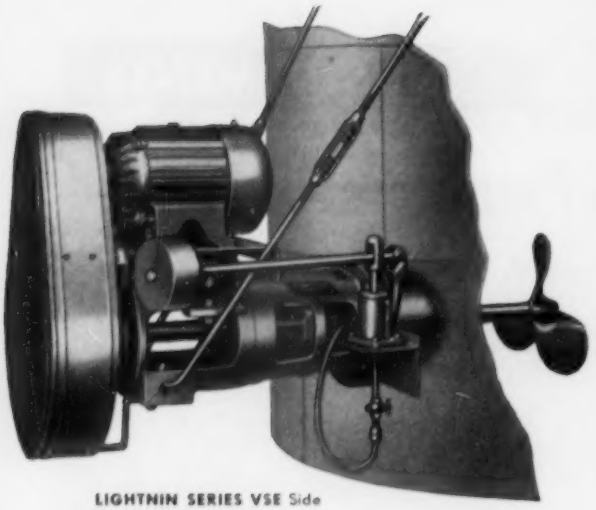


Fig. 12—Typical analytical curve for iron in oils plotted from standards obtained by spectrograph.



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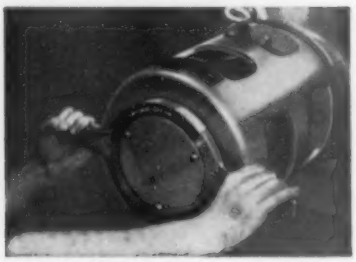

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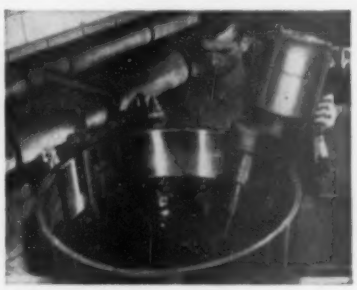

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by W. L. Nelson
Technical Editor

How to Handle Viscous Crude Oils

"How does the viscosity of crude oils change with temperature? What temperatures are required for handling a viscous oil?"—S.B.T.

Crude oils vary so widely with respect to the effect of temperature on their viscosity that only the gross approximation shown in Fig. 1 can be suggested. The viscosity-temperature lines for about 82 crude oils were published on the January 5 and 12, 1946, pages of Questions on Technology and an examination of these, along with lines for about 79 Venezuelan crude oils resulted in the average lines shown in Fig. 1. In general, the lines for United States crude oils are more steep than shown in Fig. 1, but it is thought that steeper slopes of the United States crude oils were due in part to the precipitation of wax, especially at the low temperature ranges at which these oils were tested.

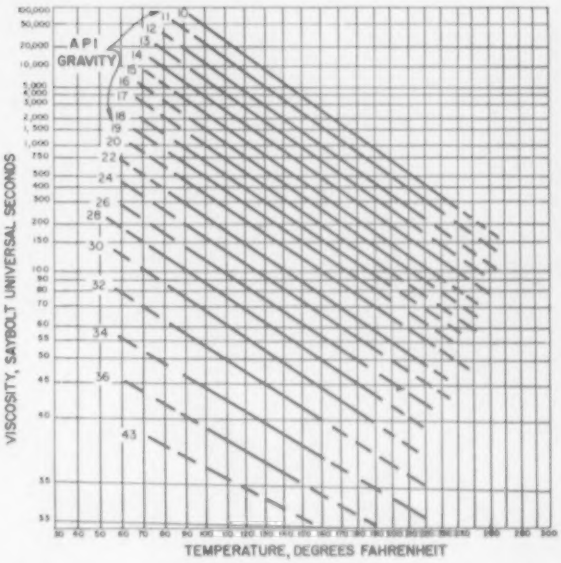

Fig. 1—Change of viscosity of average crude oils with temperature (approximate).

The common methods of handling viscous crude oils is to heat them or to dilute them. The use of pressure alone as a means of moving highly viscous oils is not feasible. The maximum viscosities that can be handled by pressure alone are somewhat as follows:

Line size	Maximum feasible viscosity for handling at room temperature S.U.s. at 100° F.
4 in.	400 (20° A.P.I.)
6 in.	1,000 (17.5° A.P.I.)
10 in.	2,000 (16° A.P.I.)
20 in.	5,000 (15.5° A.P.I.)

In general, oils can be handled in conventional systems at no significant extra cost due to viscosity, if the viscosity at the pumping temperature does not exceed about 100 S.U.s. Tanker terminals are usually able to handle more viscous oils without heating. One large operator feels that oils up to 3,300 S.U.s. (700 cs.) at the pumping temperature can be handled at normal loading rates. This corresponds to an oil having a gravity of about 14° A.P.I.

Table 1, based on Fig. 1, shows the temperatures required to reduce the viscosity of average crude oils to suitable handling temperatures. Somewhat higher temperatures are actually used so that the oil will not immediately be too cold, and in pipeline operations the oil must be reheated at the pump stations or more often.

Dilution is an excellent and often cheaper method than heating, but it cannot be applied unless facilities are available for cheap recovery of the cutter stock. Some operators have been able to mix a lighter crude oil found in the vicinity, with the heavier crude oil. Table 2 indicates the approximate amounts of cutter stocks required to obtain a viscosity of 100 S.U.s. at 100° F.

TABLE 1—TEMPERATURES REQUIRED IN HANDLING AVERAGE CRUDE OILS (°F.)

	Conventional pipelines, etc.		Handled with ease at terminals, 2,000 S.U.s. at 100° F.	Maximum at terminals for normal loading rates, 3,300 S.U.s. at 100° F.
A.P.I.	100 S.U.s. at 100° F.	500 S.U.s. at 100° F.		
10	300	215	168	155
11	285	200	155	141
12	270	185	140	127
13	255	173	128	115
14	240	160	115	103
15	225	146	104	
16	214	135		
17	202	125		
18	190	112		
19	176			
20	162			
22	143			
24	126			
26	108			

TABLE 2

Approximate Amounts of Cutter Stocks Required to Reduce Viscosity of Average Crude Oils to 100 S.U.s. at 100° F.

	Percentage of cutter stocks of	
A.P.I.	33 S.U.s. at 100° F.	50 S.U.s. at 100° F.
10	47	71
11	45	69
12	43	68
13	41	67
14	39	65
15	36	63
16	33	61
17	30	58
18	28	55
20	22	46
22	16	37
24	11	27
26	5	12

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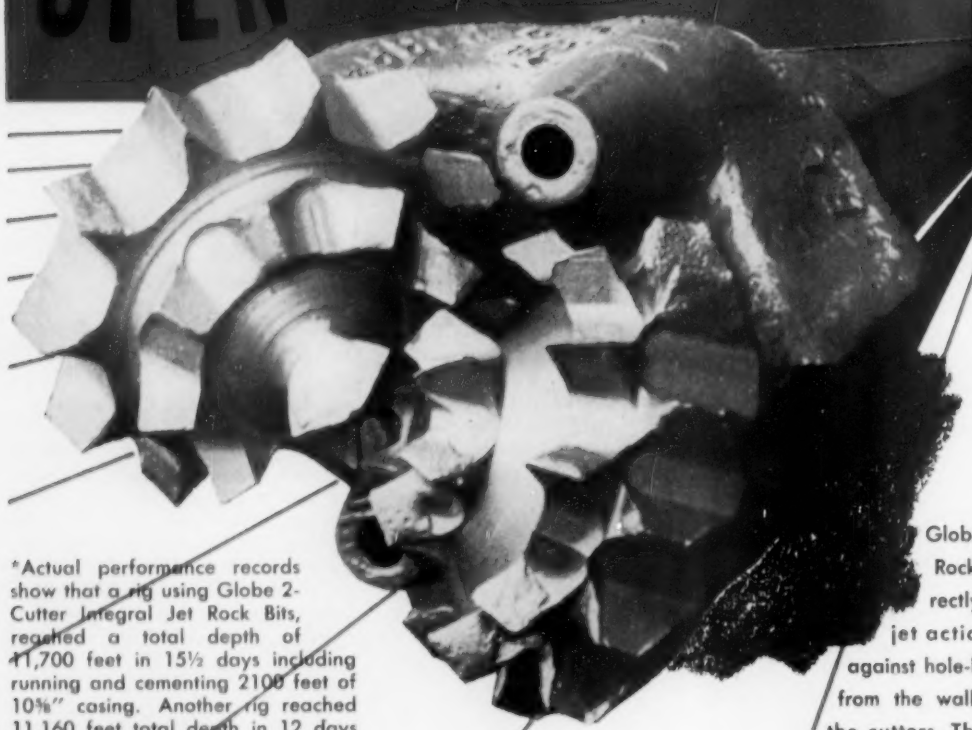

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Among the Drilling Contractors

Fast Drilling Time Made By California Contractor

Unusually fast drilling time has been made by Santa Fe Drilling Co., of Santa Fe Springs, Calif., in putting down a deep test at Guijarral Hills, in Fresno County, California.

The test, 824 Guijarral-Service, drilled for P. & T. Oil Co., was abandoned recently at a total depth of 10,319 ft. Hole was completed in elapsed time of 44 days from spudding to abandonment. This averages approximately 234½ ft. of hole per day.

Drilling ended with 8¾-in. hole being carried, using a 7⅝-in. Mercury diamond core barrel run on 4½-in. tubing string. A National 50 rig was employed.

Cut in Compensation Rate To Aid Texas Contractors

The proposed 7.43 per cent reduction in the Texas Contract Drilling Code 6202 will mean a saving of approximately $750,000 to the drilling industry of that state during the coming policy year, according to a bulletin issued by the American Association of Oilwell Drilling Contractors.

Reduction in workmen's compensation rates results from the past year's substantial improvement in loss experience as revealed in the recent 1954 Texas annual workmen's compensation rate hearing.

The association bulletin points out that if loss experience in the drilling industry continues to improve the coming year as it did the past year, another downward revision of compensation rates may be expected during the following year.

Newly Formed Firm To Operate In Mississippi

Wilson-Davis, Inc., is a newly organized drilling company operating in Mississippi and adjoining states. Main offices are established in Jackson. Principal owners are J. W. Wilson, formerly general production superintendent of Three States Natural Gas Co., Dallas; and C. C. Davis, independent operator, Jackson.

Wilson is manager of field operations. Davis is business manager. E. G. Jeffreys, geological engineer, Jackson, will be manager of the land and geological department. The company is starting with a new diesel-powered rig capable of drilling to depths up to 8,500 ft.

Kern-Trimble Expands

Kern-Trimble Drilling Co., Magnolia, Ark., has announced the establishment of a district office at Jackson, Miss., to handle its expanding contracting and other operations in Mississippi. Walter L. Cheshire is the district representative and geologist. The company previously established a branch office at Shreveport with W. E. Ranney in charge.

Loffland Brothers Co., Tulsa, will drill Seaboard Oil Co.'s projected 12,000-ft. test, 1 Weill, located in 58-13s-3e, 9 miles south of Abbeville, in Vermilion Parish, South Louisiana. Location is about 2 miles south of South Erath gas field.

Greyhound Drilling Co., El Dorado, Ark., is drilling a 4,500-ft. Smackover exploratory test 2½ miles northeast of Hampton field, in Calhoun County, southern Arkansas. The test, 1 Wilson, in 19-14s-13w, is for Herbert S. Woods, secretary-treasurer of the contracting company.

H. L. Rowley, Inc., Shreveport, is drilling on a projected 13,000-ft. wildcat test in George County, southeastern Mississippi. It is a contract job for Southern Natural Gas Co., of New Orleans. The operation is designated as 1 Green. Location is in 37-1s-8e. John Howard is Rowley's tool pusher on the job. This contractor has another new operation under way in Sweetwater field, Lincoln County, Mississippi, where it is drilling for Sinclair Oil & Gas Co. Hole is set up to go to 10,620 ft. Leland Bundy is tool pusher.

H & H Drilling Co., Wichita, is moving a rig to an outpost location 1 mile east of the new Southeast Mocane field, in northwestern Beaver County, Oklahoma, where it will drill a 7,400-ft. Mississippian test for United Producing Co., of Liberal, Kans. The test is listed as 2 Barby with location in 31-5n-26eCM.

Fowler Drilling Co., Long Beach, Calif., is under contract for three

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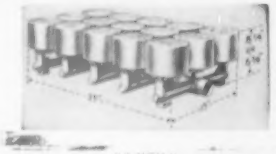

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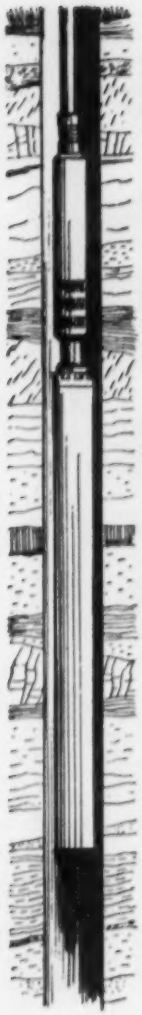

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Arizona wildcat tests to be drilled for Colorado Basin Associates, Inc., composed of a group of Yuma and Phoenix, Ariz., business men. The tests, projected to 5,000 ft., will be drilled in the Yuma area, of Yuma County. Location of the first is in 19-9s-23w.

Casey & Montgomery, Bakersfield, Calif., will drill another well for King Petroleum Co. in the North Fruitvale area, west of Bakersfield, in Kern County, California. The new operation is 2-B KCL, in 11-29-27.

Power Rig Co., Houston, is scheduled as the contractor on another 8,500-ft. well Magnolia Petroleum Co. has projected for the Hurricane Creek area, in Beauregard Parish, southern Louisiana. Location is for 3-C Four, in 28-5s-8w.

Eagle Drilling & Development Co., Natchez, Miss., has a new operation scheduled for John S. Callon, also of Natchez, in the Woodlands area, of Adams County, Mississippi. It will be another Wilcox test, 7 Hodges, with contract depth of 7,000 ft.

Wise Drilling Account, Tyler, Tex., has a rig running at a wildcat location 7 miles east of Jacksonville, in Cherokee County, East Texas. The test, being drilled for the account of W. W. Wise and L. B. Benton, also of Tyler, is projected to the Woodbine around 5,000 ft. Location is for 1 Brown, in the John Sterling Survey.

Mustang Drilling Corp., Tyler, Tex., is drilling for P. G. Lake, Inc., Leland Fikes, and Ralph Spence, of Tyler, on a new 6,000-ft. Woodbine test, 1 Dailey, in Navarro Crossing field, 12 miles west of Grapeland, in Houston County, southeastern Texas.

Carter-Jones Drilling Co., Kilgore, Tex., has a new wildcat operation of its own under way 3 miles northwest of Tatum, in Rusk County, East Texas. It is projected to the Travis Peak around 7,200 ft. Location is for 1 Adams, in the Thomas O'Bar Survey.

A **Ray Holbert** rig is drilling for Pinkston & Davis, Tyler, Tex., at 1 Pickering, a 7,500-ft. Travis Peak test, located in the William J. Crane Survey, 7½ miles northeast of Shelbyville, in Shelby County, eastern Texas.

Hinkle Drilling Co., Houston, has contracts for two 9,000-ft. tests to be drilled for C. B. Webster, Houston operator, in the Clear Creek area, of Beauregard Parish, South Louisiana. Both will be on the operator's Daniel's lease.

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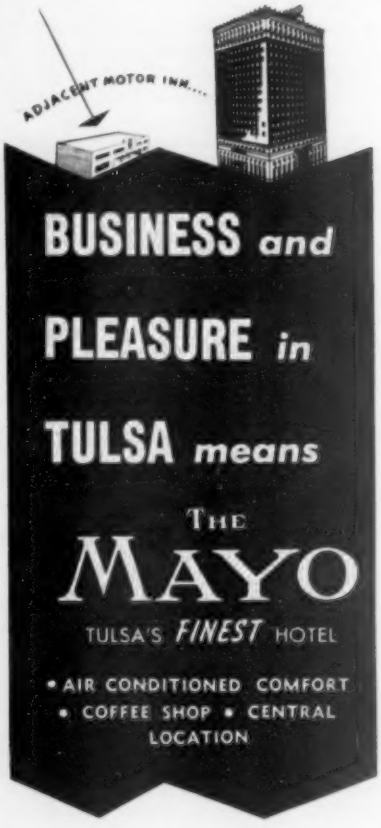

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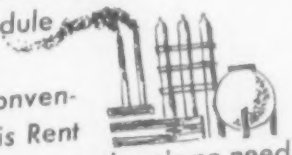

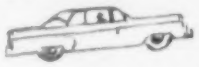

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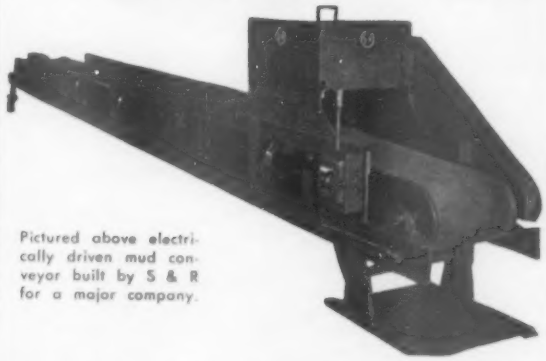

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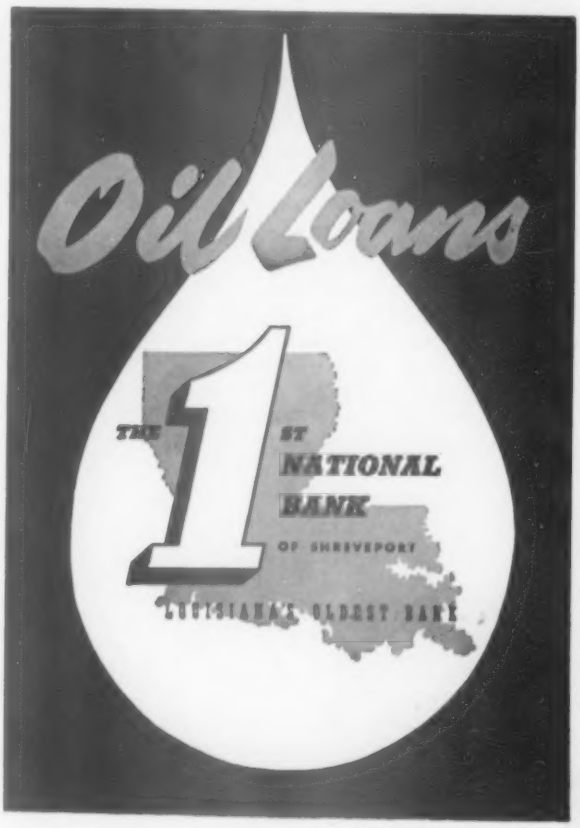

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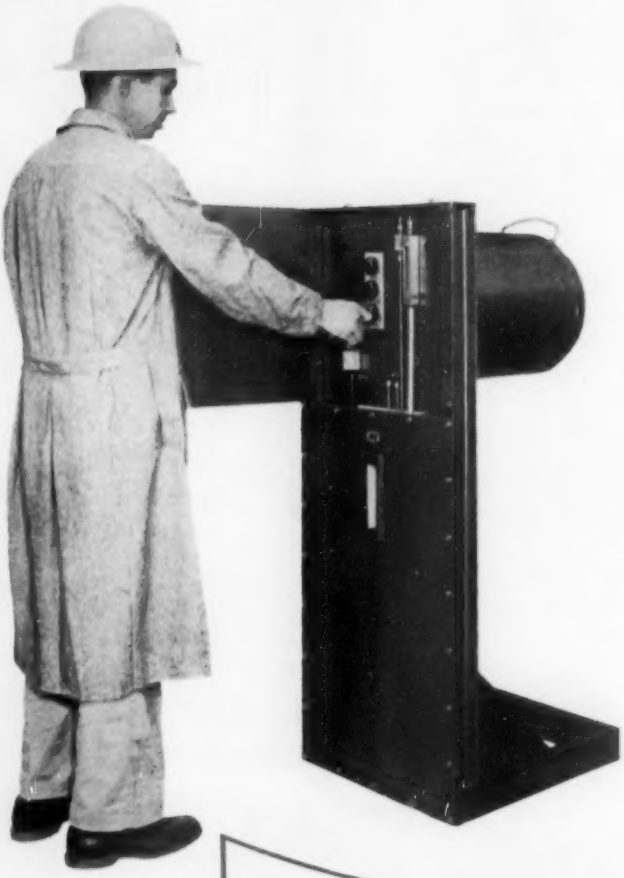

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REFINING

Estersils Discussed

New grease additive shows well in tests

SAN FRANCISCO.—Estersils, a new class of thickeners for making non-melting-point grease, were the subject of a symposium at the recent National Lubricating Grease Institute here.

Three papers by research personnel with E. I. du Pont de Nemours & Co. (Inc.), Shell Development Co., and Standard Oil Co. (Ind.) discussed the gelling agents and their uses in making all-purpose and specialty-type greases.

According to du Pont, which makes "Estersil GT," the uninhibited greases containing estersil have excellent oxidation stability because the additive, unlike conventional grease thickeners, has almost no prooxidant effect.

High mechanical stability is also attributed to the estersil greases which can be manufactured by a simple milling operation. They are buttery and transparent and have the same bloom of the oil from which they are made, the du Pont authors reported.

In addition, they reported that estersil greases which had been tested showed water resistance, little change of consistency with temperature, no melting point, and compatability with soap greases in laboratory wheel-bearing tests.

The Shell authors discussed structure of estersils and the nature of the attachment of the waterproofing coating to the particle surface. They also touched on the insufficient rust-preventive ability of many inorganic-base greases, which remains their major deficiency.

Estersil greases have performed satisfactorily in a variety of severe industrial applications, Indiana Standard investigators reported. The latter group also described several of these applications and the conditions under which the estersils were tested.

Refinery Bids Received

NEW YORK.—Bids are now in for the new 35,000-bbl. per day refinery which American Oil Co. (formerly Pan American) plans to build at Yorktown, Va. Clearing of the site has commenced, and contracts for processing and off-site facilities are expected to be let after the first of the year.

Amoco recently upped the capacity of the proposed refinery from 25,000 to 35,000 bbl. per day. It will be a fuels plant designed to produce a maximum yield of high octane gasoline.

The plant will be erected on a 1,148-acre tract fronting on the York River. Cost of the installation is estimated at approximately $25,000,000.

Construction is scheduled to begin by next summer. The project is expected to be completed some time in 1956.

Sohio Units On Stream

LIMA, Ohio.—Standard Oil Co. (Ohio) has completed one phase of a long-range expansion and modernization program at its refinery here by placing on stream a new Platforming unit combined with a Hydrobon unit.

The installation is the first of its kind to produce both high-quality burning oil and high-octane gasoline. The Hydrobon unit utilizes hydrogen from the Platformer, and treated naphtha from the Hydrobon unit is used as feed to the Platformer.

Hydrobon production includes 12,000 bbl. per stream day of Platformer feed stock and 1,000 bbl. per stream day of burning oil.

Charge stock to the Hydrobon unit consists of straight-run and coker naphthas, derived from a mixture of Illinois, Mississippi, and Arkansas crudes boiling at 200° to 450° F.

Wax Refinery Operating

WOODS CROSS, Utah.—Sure-Seal Corp. has placed on stream its $3,500,000 wax refinery here.

The plant, designed to produce fully refined waxes, will use the "waxy crude" of the Uintah basin to make its products. In addition, some other Rocky Mountain crudes will be processed.

The refinery can process 700-bbl. of crude daily, and it will turn out 35 different types of waxes. The waxes will be sold for commercial, industrial, and home use, and will range in type from a desensitizing wax, used for coating munitions, to home canning wax for jam and jelly making.

Construction of the refinery was begun in September 1953, and actual operations began one year later.

2-Year Expansion Completed

LAKE SUPERIOR, Wis.—Lake Superior Refining Co. has completed a 2-year modernization and expansion program of its refinery here.

Highlighting the construction was a

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1,000-bbl. Platformer. The unit, designed by Universal Oil Products Co., Des Plaines, Ill., was engineered and built within 24 weeks by Procon, Inc.

In addition to the reforming unit, Lake Superior also added a new vacuum distillation and asphalt unit for the production of a complete range of asphalt production products. Also the crude unit and thermal cracking unit were modified for increased operating efficiency.

Petrochemical Unit Expanded

NEW YORK.—Esso Standard Oil Co. has boosted secondary butyl alcohol production at the Bayway Refinery, Linden, N. J. from 65 to 100,000,000 lbs. per year by addition of a new recovery unit at the crude butyl alcohol plant.

A new alcohol finishing unit will be added to produce a 9.99 per cent pure butyl alcohol for conversion to methyl-ethyl ketone under an expansion program.

Tulsa Firm Awarded Contract

NEW YORK CITY.—Refinery Engineering Construction, of Tulsa, has been awarded a contract to design and to build a 9,000-bbl. Unifiner Platformer unit by The Texas Co. at its West Tulsa, Okla., refinery.

The combination unit will produce high octane gasoline with a controlled low sulfur content. The unit will also incorporate two large heaters and four high temperature reactors.

Quaker Finishes Platformers

OIL CITY, Pa.—Quaker State Oil Refining Corp. has placed 850-bbl. Platformers on stream at its Emlenton, Pa., and St. Mary's, W. Va., refineries.

Quaker had previously completed a 1,500-bbl. unit at its Farmers Valley, Pa., refinery.

All three Platformers are processing a full-boling range Pennsylvania straight-run gasoline which is low in Naphthene content. Each unit is equipped with recycle gas scrubbing facilities for removal of hydrogen sulfide.

Refinery Write-Off Approved

WASHINGTON.—Installation of a 4,100-bbl. daily fluid cat cracker at the Salt Lake City refinery of Salt Lake City Refining Co. has been approved by the Office of Defense Mobilization.

The ODM has approved accelerated amortization of 65 per cent of the $2,800,000 cost of basic facilities and 45 per cent of $530,000 for auxiliary equipment for the $3,300,000 project.

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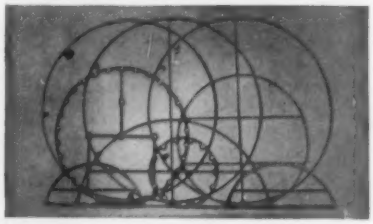

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Beautiful Scenery, but Tough on Pipeliners

THIS picturesque spot near McDonald Pass, 15 miles west of Helena, Mont., presents a thrilling view for the casual traveler; however, pipeline crews who came through here recently saw the not-too-beautiful side of the Pass. This spot at 6,325 ft., is the highest point on Yellowstone Pipe Line Co.'s recently completed products line from Billings, Mont., to Spokane, Wash. When the crews hit the side of the hill, which was covered by virgin white pine, they had to use bulldozers instead of trucks to string the pipe.

Under Way, Contracted, and Planned

PIPELINE activity as reported below by The Oil and Gas Journal is compiled from information received from pipeline companies and contracting firms.

These projects include those planned, proposed, under way, and contracted. Uncontracted projects are indicated by a • preceding the job.

Crude-Oil Pipelines

Arapahoe Pipe Line Co.—This company owned jointly by Sinclair and Pure has let contracts on a 494-mile crude line from Merino, Colo., to Humboldt, Kans. Completion scheduled for end of year. The contracts were let in the following sections:

Section 1.—146 miles of 18-in. from Merino, Colo., to Colby, Kans. R. H. Fulton Co.

Section 2.—162 miles of 18-in. from Colby to Schurr Station, Kans., R. H. Fulton.

Section 3.—84 miles of 20-in. from Schurr Station to Burns, Kans., R. H. Fulton. Completed.

Section 4.—86 miles of 20-in. from Burns to Humboldt, Panama Williams Co. Completed.

Ar-Mex Pipe Line Co.—Company has applications for two lines before the Office of Defense Mobilization Board for rapid amortization approval.

1. A crude-oil line from Albuquerque, N. M., to Phoenix, Ariz. This line would serve a 20,000-bbl. refinery being planned by Frost & Associates of Dallas.

2. A crude-oil line from Guernsey, Wyo., to Albuquerque.

• **California-Oregon Pipe Line System.**—

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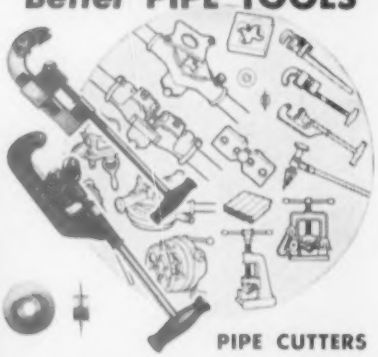
Better PIPE TOOLS



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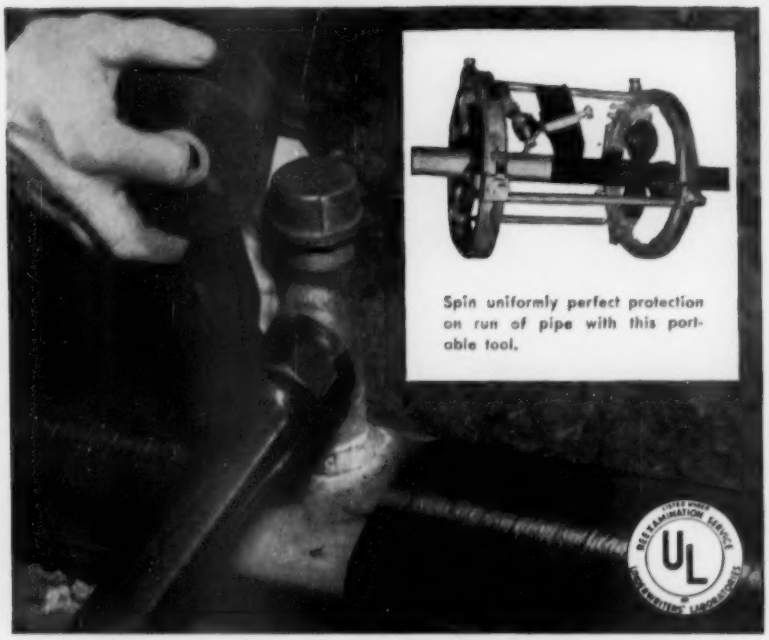

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Pipeline Patrol

103 miles 6-in., proposed, Crescent City, Calif., to Medford, Ore.

Cheyenne Valley Pipe Line Co.—Company planning a 96-mile, 10-in. crude line from Lance Creek to Fort Laramie, Wyo. Line will cost $1,838,241 and will connect with the Platte Pipe Line system at Fort Laramie.

Continental Pipe Line Co.—Has awarded contract to G. G. Griffis Construction Co. to build 64-mile, 12-in. crude line from Oklahoma City to Ogg Station near Tonkawa, Okla. The line will give Conoco a complete 12-in. system between Wichita Falls, Tex., and the company's Ponca City, Okla., refinery. Work winding up.

Interstate Oil Pipe Line Co.—Company will build 32 miles of 8-in. crude line from Gwinville field of Jefferson Davis County, Mississippi, to the Soso field in the tri-county area of Jones, Jasper, and Smith counties, Mississippi. Houston Contracting Co. has contract. Job will be done by November 25.

Magnolia Petroleum Co.—This company will operate a 48-mile, 12-in. submarine pipeline for itself and Continental Oil Co., and Newmont Oil Co. The line will run to blocks off the coast of St. Mary's Parish, Louisiana, and will have a capacity of 50,000 bbl. per day. Brown & Root, Houston, has the contract and expects to be finished by the middle of 1955.

Minnesota Pipe Line Co.—Williams Brothers Co. has contract to build this 260-mile, 16-in. crude line from Clearbrook to Hastings, Minn. The line, to cost $12,500,000, is the southern end of a system which will move crude from Fosterton field, Sask., to Great Northern's refinery which is building in the Minneapolis-St. Paul area. Present plans call for completion by July 1955.

• **NNCW Pipeline Co.**—127-mile line, proposed, from Weston County, Wyoming, to Casper. 108 miles of 10-in. and 19 miles of 8-in. Est. cost: $3,500,000.

Shell Pipe Line Corp.—Company has awarded Anderson Bros. Corp. a contract to lay 35 miles of 12-in. crude line from Cabin Creek field in Montana to a tank-car loading rack on the Northern Pacific Railroad near Glendive, Mont.

Standard Pipe Line Co.—Company plans to build two crude lines. Applications are now before the Office of Defense Mobilization for rapid amortization approval.

1. A 350-mile, 16-in. crude line from Glendive, Mont., to Guernsey, Wyo., to connect with Platte Pipe Line Co.'s system there.

2. A 330-mile, 16-in. crude line from Wink, Tex., to Albuquerque, N. M. This line would serve a 10,000-bbl. refinery being planned by Frost & Associates of Dallas.

• **Union Oil Co. of California.**—Planning construction of a 60-mile crude line from its Clara Valley field to its Wilmington refinery. Line is expected to be completed by late this year. 12-in. line. Bids being asked.

Western Pipe Line Co.—This subsidiary of Service Pipe Line Co. has let contracts for 630 miles of 20, 22, and 24-in. crude line from Fort Laramie, Wyo., to Freeman, Mo. The western section of the line will be laid by H. B. Zachry Co. and the eastern section will be constructed by O. R. Burden Construction Corp. Completion set for December 1.

Products Pipelines

• **American Pipe Line Co.**—Has received ODM approval to amortize 40 per cent of $178,000,000 with a rapid writeoff on proposed line to run from Gulf Coast area to New York City area. Bids for pipe requested.

Badger Pipe Line Co.—Company to build 195 miles of 8-10-12-in. pipeline from East

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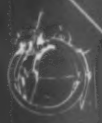
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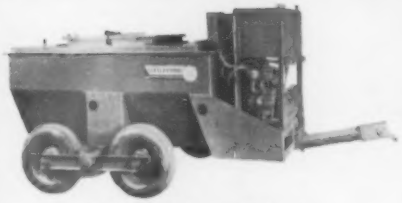
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Chicago, Ind., to Madison, Wis. One section of 40 miles has been let to Morrison Construction Co. of Hammond, Ind. 2d section of 32 miles from Lockport to Des Plaines, Ill., let to Contract and Material Co. of Evanston, Ill.

65 miles of 12-in. from Des Plaines to Rockford let to Contracting & Material Co. Evanston, Ill.

56 miles of 12-in. from Rockford to Madison let to Mid States Construction Co. of Mount Vernon, Ill.

• **H. W. Bass & Sons, Inc.**—152 miles, 4-6-in., proposed. Duval and Live Oak counties, Texas, to Corpus Christi, Tex.

Buckeye Pipe Line Co.—This company has awarded 80 miles of 8-in. products line between Lima and Columbus, Ohio, to Sheehan Pipe Line Construction Co. of Tulsa. The line is expected to be in operation by the end of the year.

Cherokee Pipe Line Co.—Company will convert a recently purchased crude line into an aviation and jet fuel carrier from Ponca City, Okla., to Wichita. The company also plans to lay about 8 miles of line to complete the present system into Wichita. Line will serve refineries of Continental Oil Co., and Cities Service Oil Co., joint owners of Cherokee.

• **International Pipe Line, Inc.**—132 miles 8-in., proposed, Wrenshall to Minneapolis, Minn. Cost: $4,200,000.

Maico Pipeline, Inc.—Company planning to build a 91-mile, 6-in. products line from its Prewitt, N. M., refinery to Albuquerque.

Moore Stoner Co.—Company has $2,500,000 tax amortization for a 200-mile, 6-in. products line from a connection with Oil Basin Pipe Line Co.'s terminal at Glendive, Mont., to Minot, N. D.

Oil Basin Pipe Line Co.—Midwestern Constructors, Inc., doing the work on this 230 miles of 8-in. products line from Laurel to Glendive, Mont. Cost: $5,350,000.

Phillips Petroleum Co.—Company has let 72 miles of 8-in. line to Somerville Construction Co. of Ada, Mich. Work being done between East St. Louis and Kankakee, Ill.

Shell Pipe Line Corp.—65 miles of 12-in. products line from Baton Rouge, La., to Shell's Norco refinery. Houston Contracting Co. has contract. H. T. Muckley, Supt. Job held up indefinitely by right-of-way difficulties.

Standard Oil Co. of Texas.—Company laying a 248-mile, 6-in. products line from El Paso to Albuquerque. The line will move 5,000-bbl. daily when finished and will cost $4,000,000. Houston Contracting Co. has job.

• **Sunflower Pipe Line System.**—Company proposes to build a 215-mile, 6-in. line to transport LPG from six counties in western Kansas to Wichita. Application approved by Kansas Corporation Commission.

Texas Eastern Transmission Corp.—Company has asked FPC permisison to abandon "Little Inch" gas line. If permission is granted, company will spend $71,000,000 converting the line to a products line with a capacity of 235,000-bbl. per day.

U. S. Gov't. Alaskan Products Pipe Line.—600 miles of 8-in. under way from Haines northward through Yukon to Fairbanks, Alaska. Williams Bros., McLaughlin, Inc., and Marwell Construction Co. are doing the work. Pipe laying will be through by November of 1954; however, entire job not expected to be completed until September of 1955.

Natural-Gas Pipelines

• **American-Louisiana Pipe Line Co.**—1,121 miles of 30 and 22-in., 30-in., proposed,

W. L. WALKER CO.

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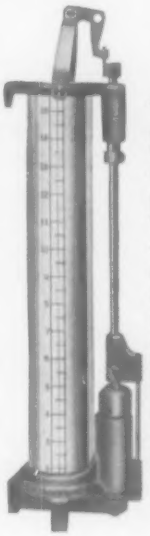

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Pipeline Patrol

extends from North Tepetate, Acadia Parish, Loupisiana, to near Detroit. The 22-in. starts near Payne, Ohio, extends to Bridgman, Mich. Estimated cost: $130,000,000. FPC approved.

• **Arkansas Louisiana Gas Co.**—136 miles of new line proposed, to be added to present system in Arkansas, Louisiana, and Texas. Estimated cost: $9,245,166. FPC approved.

• **Carolina Natural Gas Corp.**—185 miles, 2-12-in., proposed, later lines off Transcontinental in North and South Carolina.

• **Central Hudson Gas & Electric Corp.**—Company has filed application with FPC to construct 48 miles of 12-in. line from Albany to Kingston, N. Y. Line will be started and completed in 1955 if FPC approves.

Chicago District Pipe Line Co.—19 miles of 36 and 30-in., completed of 35 miles planned. Remainder, all 30-in., will be completed in 1954.

• **Cities Service Gas Co.**—24 miles of 26-in., planned, to replace two existing 16-in. lines in Franklin and Johnson counties, Kansas. F.P.C. approved.

Nine miles of 20-in. to replace existing 16-in. line in Cherokee and Jasper counties, Missouri. F.P.C. approved.

• **City of Dalton, Ga.**—Proposes to build 39 miles of 8-in. from a point of interconnection with Southern Natural's Rome-Calhoun transmission line. Estimated cost: $2,940,000.

• **City of Fayette, Ala.**—20 miles, 5-in., F.P.C. approved, Fayette, Ala., to Southern Natural's system in Tuscaloosa County, Alabama. Completion set for early 1955.

• **Colorado Interstate Gas Co.**—365 miles, 22-in., approved by F.P.C., Green River, Wyo., to Denver, Colo., 1954.

• **Colorado-Western Pipe Line Co.**—454 miles of undetermined size pipe planned between Cortez in Montezuma County and Denver. Line would serve towns of Montrose, Gunnison, Salida, Fairplay and South Platte, Colo. Estimated cost: $30,000,000. Company also plans 254 miles of laterals to service Colorado cities not now receiving natural gas.

328-mile line, proposed, to run from a point in La Plata County in southwestern Colorado over the Continental Divide along the eastern slope to serve Pueblo, Colorado Springs, and Denver. Estimated cost: $21,600,000.

• **Fort Worth Basin Gas Co.**—Planned, Novice, through Brown and Comanche counties, Texas.

• **Home Gas Co.**—Work under way on 24 miles of 12-in. from Halsey Valley to Westover, N. Y.

Work under way on 25 miles of 12-in. from Port Dickinson to Deposit, N. Y.

• **Hope Natural Gas Co.**—Proposing to ouild a 22½-mile extension of existing line from Boone County, West Virginia, to Logan-Mingo County line, West Virginia. Estimated cost: $930,000.

• **Houston Texas Gas & Oil Co.**—Company proposes to build three natural gas lines. One line would run from lower Rio Grande Valley to Chicago. The other line would go from southern Louisiana to New York City. Third line would run from Louisiana to Florida., 20, 24, 30-in., pipe considered in plans. Engineering firm reported preparing an economic report on the lines at present.

• **Iroquois Gas Corp. and Tennessee Gas Transmission Co.**—Companies planning joint storage project to be known as Colden storage field in New York. The following delivery and gathering lines are planned:

17 miles, 16-in. delivery line.

62 miles, 12, 8, 6, and 4-in. gathering lines.

• **Iroquois Gas Corp.**—25 miles of 20-in. line, approved by FPC, from Iroquois' Porter-

ville station near Elma, N. Y., to Tonawanda, N. Y. Est. cost: $1,540,000.

• **Kansas-Nebraska Natural Gas Co., Inc.** Proposes to construct 206 miles of 6-12-in. pipeline to add to present system in central and northeastern Nebraska.

• **Manufacturers Gas Light & Heat Co.**—40 miles, proposed, Allegheny, Washington and Beaver counties, Pennsylvania.

213 miles, 3 to 26-in., proposed, various points on system in Pennsylvania, West Virginia, and Ohio.

72 miles, 16-20-in., Doddridge, Wetzel and Marshall counties, West Virginia. Fulghum Contracting Co. doing work.

• **Michigan Consolidated Gas Co.**—25 miles, 12-in., proposed, from near Sparta to Muskegon, Mich.

• **Michigan Wisconsin Pipe Line Co.**—251 miles, proposed, 24, 18, 12, 6, and 4-in. loops. Majority will be in Wisconsin.

• **Missouri Central Gas Co.**—25 miles, 6-in., proposed, Moberly to Macon, Mo.

• **Missouri Public Service Co.**—136 miles, 8-10-in., proposed, New Franklin to Trenton, Mo.

24 miles, 10-in., Johnson County to Clinton, Mo. FPC approved. Est. cost: $600,000.

• **Montana-Dakota Utilities Co.**—Proposes to build 56 miles of 2, 4, and 6-in. line from its 12-in. Cabin Creek-Bismarck line near Gladstone, N. D., to the towns of Lefor, Regent, New England, and Mott, N. D.

• Proposed 34½ miles of 12¾-in. line to run from Baker-Glendive field in Montana to Rapid City, S. D., and 14 miles of 12¾-in. to replace various lines in Park County, Wyoming, and Carbon County, Montana.

Natural Gas Pipe Line Co. of America.—Company has proposed a 280-mile line from Wise County, Texas to Panhandle field in Texas where it would connect with the Peoples Gas & Light Co. line to Chicago.

• **Natural Gas Producer, Inc.**—100 miles, 12-in., planned, Yenter pool to Denver, Colo.

• **New River Gas Co.**—50 miles, planned, Summers to Monroe counties, West Virgina, to Narrows and Dublin, W. Va.

• **North Dakota Gas Transmission Co.**—470-mile line from Tioga plant of Signal Oil & Gas Co., and Beaver Lodge field to Fargo and Grand Forks, N. D. Line will have 78 miles of 12-in., 215 miles of 10-in., 70 miles of 8-in., and 107 miles of 6-in. Estimated cost: $10,800,000.

• **Northern Indiana Fuel & Light Co.**—35 miles, 8-in., planned, Edgerton to Auburn, Ind.

Northern Natural Gas Co.—Company has just recently finished a large summer expansion. Still planned are:

170 miles of 20-24-in. line in Minnesota and Wisconsin running from Duluth to Superior.

400 miles of 24-in. line from the Canadian border to tie in with its system at St. Paul-Minneapolis.

500 miles of 24 or 30-in. planned across North Dakota from Tioga past Minot to Fargo and from there eastward to the Twin Cities.

• **Northwest Alabama Gas District.**—40 miles, 9-in., proposed, Southern Natural's line through Winfield to Haleyville, Ala.

• **Ohio Fuel Gas Co.**—31 miles, 20-in., planned, Licking County to Richland County, Ohio.

22 miles, 16-in., planned, Dayton, Troy, Piqua, and Sidney, Ohio.

23 miles, 16-20-in., planned, Wellington to Elyria, Ohio; 16 miles, 20-in., planned, Benton Station to Crawford Station; 18 miles, 20-in., Crawford Station to near Columbus;

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16 miles, 16-in., planned, Berlin to Sandusky, Ohio.

74 miles, 3 to 20-in., planned, Hocking, Knox., and Ashland counties, Ohio.

47 miles, 20-in., planned, Benton Township, Hocking County, to Columbus, Ohio.

61 miles, planned, northern and southwestern Ohio.

33 miles, 20-in., proposed, Jefferson to Seneca, Ohio.

69 miles, 20-24-in., proposed, lines to tiein Gulf Interstate line along various points in Lawrence, Jackson, Vinton, Hocking, and Fairfield counties, Ohio.

Pacific Gas & Electric Co.—200 miles, 34-in,. planned, paralleling Topock-Milpitas lines. 93 miles completed. 107 miles contracted to Engineers Limited Pipe Line Co. L. E. Robertson is in charge of the spread handling work from Newberry to Danby and from Los Muertos Creek to Gilroy, Calif. Completion November 1954.

15 miles, 20-in., planned for completion in 1955 from Helm Tap to Helm Junction, Calif. Alex Robertson Co.

15 miles, 12-in., planned for completion in 1955. From Herndon to Madera, Calif. Company forces.

• **Pacific Northwest Pipeline Corp.**—1,466 miles, proposed, Ignacio, Colo., to Bellingham, Wash. Approved by FPC.

380 miles, proposed, laterals and spurs off main line to Pocatello, Idaho, to Yakima, Wash.

Panhandle Eastern Pipe Line Co.—FPC has given this company a temporary certificate to construct 295 miles of 30-in. looping to get additional gas to companies in Illinois, Indiana, Michigan, Ohio, and Missouri before cold weather. The job is costing $22,885,000 and is part of a $66,750,000 expansion program. The remainder of the program calls for $23,580,000 for new compressors and the leaching out of an underground storage cavity near Waverly, Ill., and $11,427,500 for production and gathering facilities improvements in the field.

• **Pine Tree Natural Gas Co.**—204 miles of undetermined size pipe to run from the Boston area to Bangor, Me.

• **Shenandoah Gas Co.**—40 miles, 3-4-8-in., proposed, Middleton, Va., to Martinsburg, W. Va. Est. cost: $1,470,000. FPC approved.

• **South Georgia Natural Gas Co.**—368 miles, 2-12-in., planned, Phoenix, Ala., to Tallahassee, Fla. (a) 12-in., Phoenix, Ala., to Albany, Ga., (b) 10-in., Albany, Ga., to Moultrie, Ga., (c) 8-in., Moultrie, Ga., to Tallahassee. Est. cost: $9,000,000. FPC approved.

• **Southwest Alabama Gas District.**—150 miles, 10 and 8-in., planned, Phoenix City to Dothan, Ala. Engineering Const. Co.

Tennessee Gas Transmission Co.—243 miles 24-in., planned, Coudersport, Pa., eastward across Pennsylvania, New Jersey, and New York to point near Greenwich, Conn.

• **Texas Eastern Transmission Corp.**—Proposed, 382-mile, 24-in. line from Kosciusko, Miss. to Beaumont, to connect with the existing 30-in. line there to Connellsville and replace the "Little Inch" in moving natural gas.

• Company proposes to build 58 miles of 20 and 16-in. pipeline from Joaquin to Longview, Tex. Cost: $3,269,000. FPC approved.

• **Texas Gas Transmission Corp.**—48 miles, 26-in., planned, loops from Memphis to Slaughters, Ky.

24 miles, 16-in. line planned from North Tepetate field, Acadia Parish, Louisiana, to South Roanoke field in Jefferson Davis Parish, Louisiana. Work to be done in September and October by Houston Contracting.

• **Transcontinental Gas Pipe Line Corp.**—421 miles, 30-36-in., looping along Texas-New York line.

• 19 miles of 12.75-in. pipe starting at West White Lake field in Vermilion Parish, Louisiana, and connecting with applicant's transmission line in same parish. Estimated cost: $1,042,310. FPC approval received.

• 57 miles of 36 and 30-in. paralleling sections of its existing system in Louisiana, Mississippi, and Alabama. Approved by FPC. Est. cost: $6,533,000.

• 25 miles of 12-in. in Cameron and Calcasieu parishes, Louisiana, to additional gas reserves. Est. cost: $1,000,000.

• **Trunkline Gas Co.**—Proposes to cross the Mississippi River with two 24-in. lines near Greenville, Miss. Est. cost: $2,960,000.

• **Utah Natural Gas Co.**—Planning 40 miles from Orem to Salt Lake City, 16-in. pipe at later date. Contract not let yet.

Virginia Natural Gas Co.—153 miles, Buckingham to Richmond and Portsmouth, Va.

Foreign Crude-Oil Pipelines

• **Atlas-Dresser.**—Included in this company's agreement with the Argentine Government are plans to built a 400-mile, 16-in. crude line from Plaza Huincul area to Bahia Blanca.

Bombay Port Trust.—50 miles, 8 to 24-in., contracted, Bombay, India, to serve Standard Vacuum Oil Co., and Burmah Shell refineries. Merritt, Chapman & Scott Corp., contractors. (Crude and Products). Collins Const. Co. has subbed 84,000 ft. of Subaqueous work. Shutdown for Monsoon season during summer. Work resumed September 15.

Interprovincial Pipe Line Co. and Lakehead Pipe Line Co.—Contracts have been awarded for 604 miles of looping; 454 miles will be in Canada, the remaining 150 miles will be in the United States.

201 miles of 24-in. between Regina and Gretna, Man., have been awarded to Anderson International Contractors, Ltd., of Edmonton, Alta.

Mannix, Ltd., of Calgary, Alta., will lay 129 miles of 24-in. line between Edmonton and the Alberta-Saskatchewan boundary.

Fulton-Bannister, Ltd., has contract for 125 miles of 24-in. line to connect the lines being built by Anderson and Mannix.

R. H. Fulton & Co., of Lubbock, Tex., has the contract for 104 miles of 26-in. looping from the Canadian border southeast. Anderson Bros. Corp. has contract for 50 miles of 26-in.

• **Pembina Pipe Line Co., Ltd.**—Company building 325 miles of 3-12-in. gathering line from Pembina field and a 72-mile, 16-in. transmission line to the terminals of Trans Mountain Pipe Line Co., and Interprovincial Pipe Line Co. at Edmonton, Alta. Work winding up.

• **Petroleos Mexicanos.**—145 miles, 12-in., considered, 18 de Marzo field via Reynosa to Monterrey, Mexico.

100 miles, planned, Isthmus of Tehuantepec, Jose Colomo to El Plan field, Minatitlan.

72 miles, 12-in., proposed, Poza Rica to Atzacapotzalco, Mexico.

• **Petroleos Mexicanos.**—145 miles, 12-in., under way, Jose Colomo to El Plan, Mexico.

South Saskatchewan Pipe Lines, Ltd.—Fulton-Banister, Ltd. has contract to construct 150 miles of 16-in. crude line from Fosterton field in Saskatchewan to a con-

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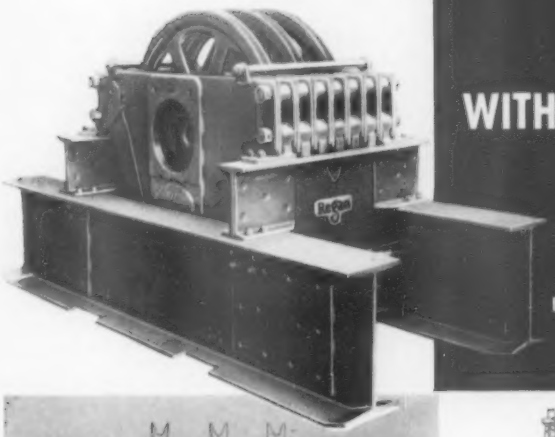

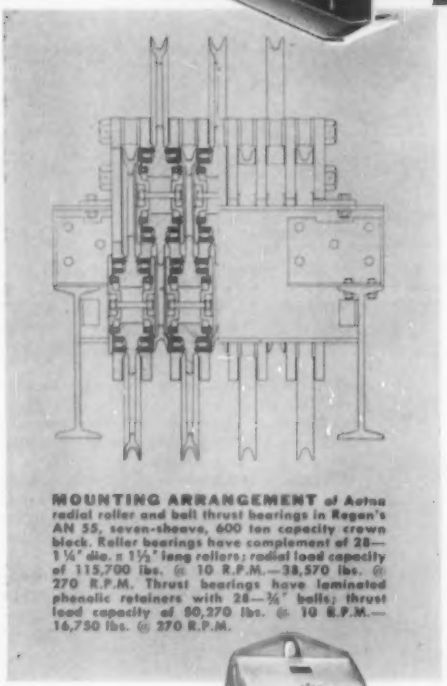

MOUNTING ARRANGEMENT of Aetna radial roller and ball thrust bearings in Regan's AN 55, seven-sheave, 600 ton capacity crown block. Roller bearings have complement of 28—1¼" dia. x 1½" long rollers; radial load capacity of 115,700 lbs. @ 10 R.P.M.—38,570 lbs. @ 270 R.P.M. Thrust bearings have laminated phenolic retainers with 28—¾" balls; thrust load capacity of 80,270 lbs. @ 10 R.P.M.—16,750 lbs. @ 270 R.P.M.

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nection with Interprovincial Pipe Line Co.'s system at Regina. Line will have a capacity of 20,000-bbl. per day, will cost $10,000,000 and is expected to be finished by November.

Texas Petroleum Co.—Contract has been let to Foster Wheeler Corp. and Panama-Williams for a 119-mile 12-in. crude line to move oil from Velasquez field in Colombia to a connection with the main Andian National system at Galan. Est. cost: $6,000,000.

• **Yacimientos Petrolíferos Fiscales Bolivianos.**—170 miles, 4-in., planned, Bermejo to Tupiza, Bolivia.

Yacimientos Petrolíferos Fiscales Bolivianos.—Bolivian Government oil organization has awarded contract to Williams Brothers, Sudamericana, Ltd., to construct a 6-in. crude line from Camiri field to Yacuiba on the Argentine border. The project will cost approximately $2,500,000.

Foreign Products Pipelines

Anglo-Iranian Oil Co., Ltd.—18½ miles 16-in., under way, Little Aden to Aden. Bechtel Corp. Completion date December 1954.

18½ miles, 6-in., under way, Little Aden to Aden,. Bechtel Corp. Completion date December 1954.

15 miles, 12-in., under way, Kwinana to Fremantle, M. W. Kellogg Co. Completion date February 1955.

17 miles, 6-in., Kwinana to Fremantle. M. W. Kellogg Co. Completion date February 1955.

Australasian Petroleum Refinery, Ltd.—Company plans two lines from the new Kwinana refinery in western Australia to the port of Fremantle to be completed early in 1955. One line will be 15 miles of 12-in. The other line will be a 17-mile, 6-in. line.

• **Empresa Nacional del Petroleo** — 80 miles, 6⅝-in., planned, Concon to Santiago, Chile.

• **Governments of Southern Rhodesia and Portuguese East Africa.**—200 miles, considered, Beria, Portuguese Mozambique to Umtalia, Southern Rhodesia.

North Atlantic Treaty Organization (NATO).—1,920 miles, 4-10-in., to serve military bases in Western Europe (to connect with U. S. Government's St. Nazaire-Paris-Metz line). Contracted by Soc. Foster Wheeler Francaise.

• **Petroleos Mexicanos.**—124 miles, 6-in., planned, Lagos to Guadalajara, Mexico.

54 miles, 6-in., planned, Lagos to Aguascalientes, Mexico.

82 miles, 8-in., planned, Salamanca to Lagos, Mexico.

• **United States Government.**—375 miles, 12-in., planned, St. Nazaire to Melun and Metz, France.

• **United States Navy Department.**—Proposed 300-500-mile line to be built in Spain to serve a proposed naval base and four large air bases which are also proposed under a defense agreement with the Spanish Government. No definite size or cost is known now.

Foreign Natural-Gas Pipelines

Alberta Gas Trunk Line, Ltd.—This Canadian firm has let engineering contracts to two firms, Dutton, Williams Brothers, Ltd., and Mannix, Ltd. for a 300-mile, big inch gas-gathering system to collect Alberta's natural gas for transportation to Trans Canada Pipe Line Co.

Attock Oil Co.—Company plans to build 60-mile natural gas pipeline from Dhulian field to Rawalpindi in West Pakistan.

Azienda Generale Italiana Petroli — 90 miles, 12-in., under way, Cortemaggiore to Bologna, Italy, SNAM crews.

120 miles, 16-in., under way, Cremona Porto Mar to Ghera, Italy, Montubi, contractor.

40 miles, 12-in., under way, Ripalta-Bergamo, Italy.

• **Empresa Nacional del Petroleo** — 80 miles, 10-in., planned, Concon to Santiago, Chile.

Petroleos Mexicanos. — 205 miles, 16-in., under way, Monterrey to Torreon, Mexico.

• **Petroleos Mexicanos.**—440 miles, 20-in., planned, Brazil to Tampico to Poza Rica, Mexico.

Winnipeg & Central Gas Co.—Company has plans for a $20,000,000 propane-pipeline network. Line will extend from Alberta gas fields to Winnipeg and from Winnipeg to Tioga, N. D. Plans are still incomplete.

Sui Gas Transmission Co., Ltd.—Morrison-Knudsen Construction Co. has contract to build 350-mile, 16-in. line from Sui field to Karachi in West Pakistan. Est. cost: $25,000,000.

• **Trans-Canada Pipe Lines, Ltd., Canadian Delhi Oil Co.)**—2,247 miles, 14 to 30-in., proposed, Alberta to Toronto to Montreal.

747 miles, 8 to 24-in., gathering system in Alberta.

• **Union Gas Co. of Canada, Ltd.**—Proposed line from Lambton County gas-storage fields to Oakville. Line is being proposed now and will eventually join with proposed line from Alberta to Toronto and Montreal.

Private Interests.—Proposes to build gas line from Gubik gas field near Navy Petroleum Reserve No. 4 in Alaska to Fairbanks. Line would be 450-mile, 8-in. line and Arctic Contractor, Inc., who handled engineering requirements and preliminary design estimated the line would cost $20,000,000, although later figures have been much higher than this.

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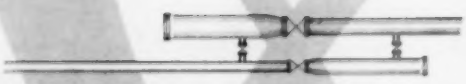

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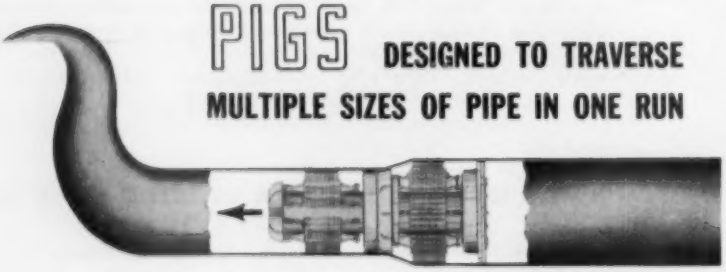

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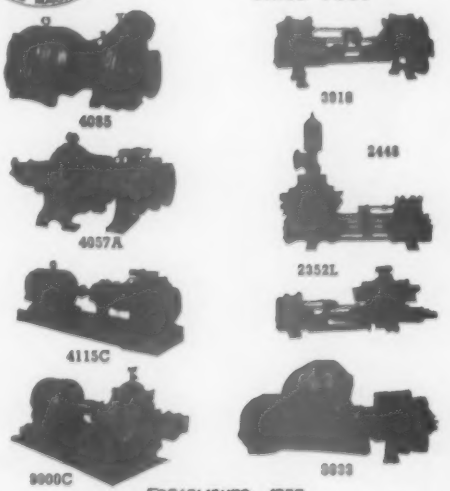

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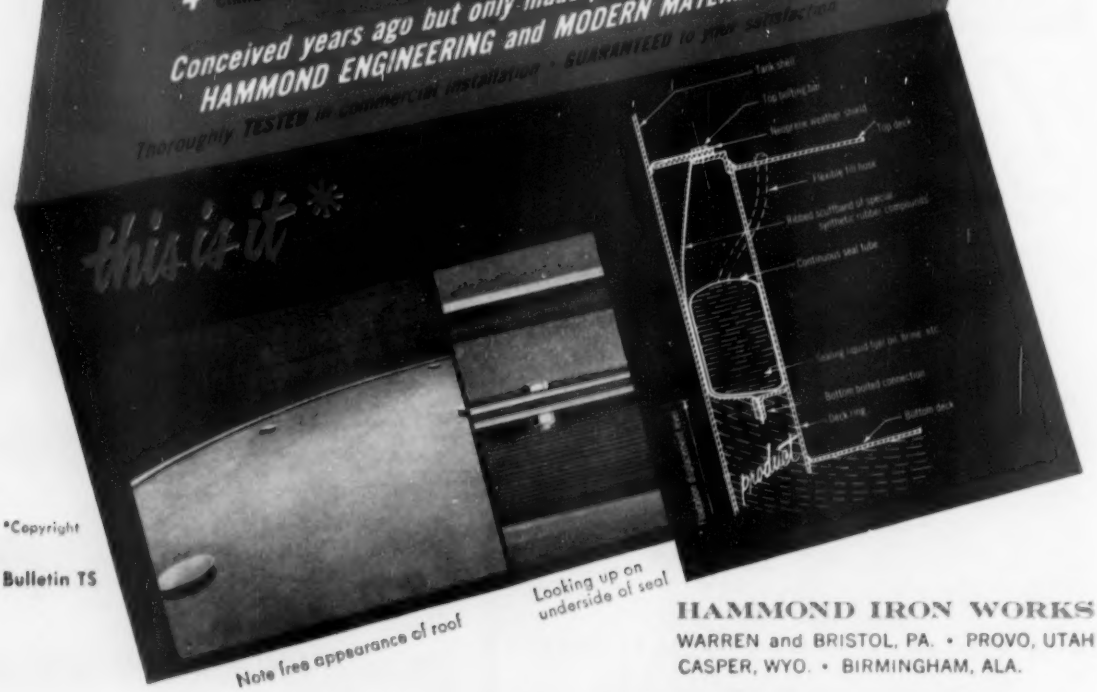
new or old—riveted or welded

THE MOST EFFICIENT AND POSITIVE SEAL KNOWN

1 no moving parts
2 no mechanical maintenance
3 overcomes tank out-of-roundness
4 climate proof
5 non corrodible
6 can operate to bottom of tank or above the top
7 no vapor space below the seal
8 entire circumference has tight seal under pressure at all times

Conceived years ago but only made possible by combining HAMMOND ENGINEERING and MODERN MATERIALS

Thoroughly TESTED in commercial installation · GUARANTEED to give satisfaction



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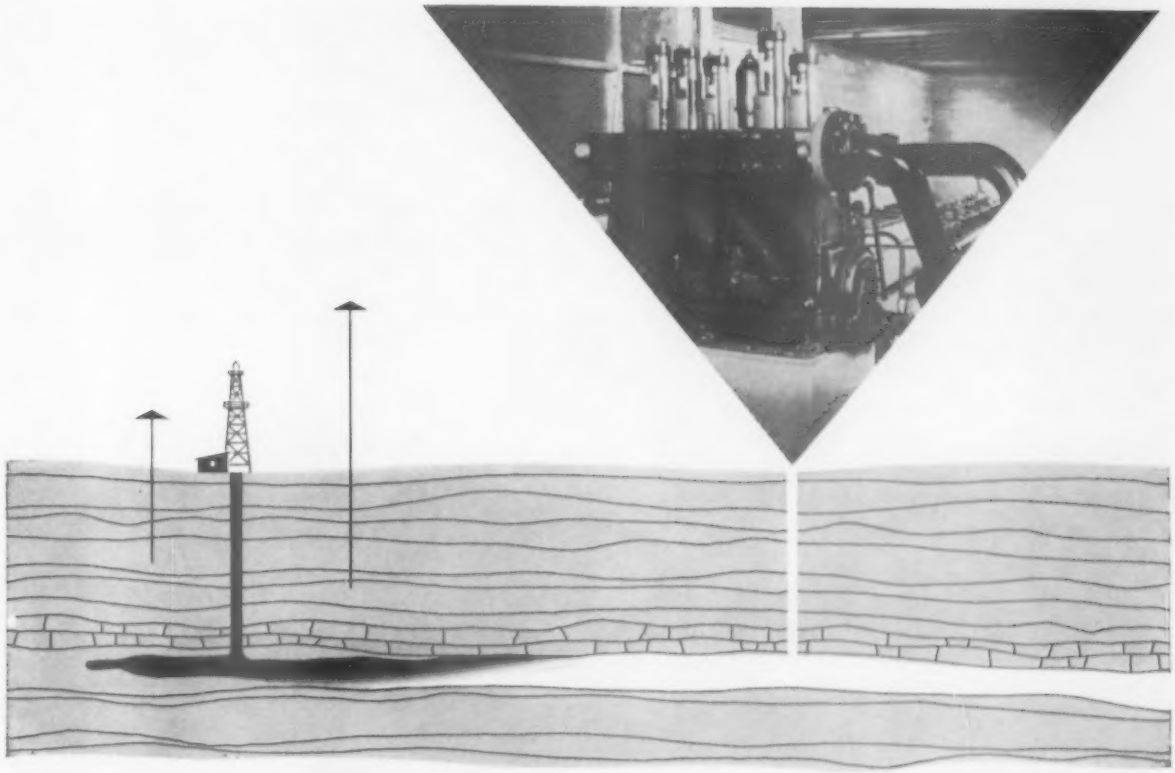

USE ALDRICH Direct Flow pumps for water flooding

Outstandingly satisfactory performance at varying pressures in water flood installations throughout the country gives proof of quality.

- *high speed*—greater volume from more compact pumps.
- *low maintenance costs*—KOSMOS Porcelain Plungers and completely sectionalized fluid-ends reduce maintenance, material costs and down time.
- *complete range of sizes*—3″ Triplex, 5″ and 6″ Triplex and Multiplex units permit optimum combinations of pumps with maximum interchangeability of parts.
- *for corrosive service*—fluid-ends available in stainless steel or aluminum bronze.

Ask for proof of performance in any field.

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. . . Originators of the Direct Flow Pump

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Representatives: Bushnell Controls & Equipment Co., Inc., 5137 West Jefferson Blvd., Los Angeles 16, Calif. • Cross Pump & Equipment Co., P.O. Box 889, Charleston 23, W. Va. • Lloyd T. Gibbs Co., 1021 Petroleum Bldg., Tulsa 3, Okla. • Lloyd-Smith Co., Inc., Bradford, Pa. • Walter Harris Engineering Co., Civic Opera Bldg., 20 North Wacker Drive, Chicago 6, Ill. • Power Specialty Co., P.O. Box 6365, 2000 Kipling Street, Houston 6, Texas; The Suburban Bldg., Room 204, 5526 Dyer Street, Dallas 6, Texas • H. G. Harmon Service & Equipment Co., P.O. Box 309 (Farm Bureau Bldg.), Carmi, Ill. • Storms-Roger Manufacturing Co., 1720 California Street, Denver 2, Colo. • Export: Petroleum Machinery Corporation, 30 Rockefeller Plaza, New York 20, N. Y.

Direct Flow Spare Parts Stock—at Carmi, Ill., Houston, Los Angeles, Odessa, and Tulsa

Gas-Turbine-Powered Pump on Test at Navy Fire Fighting School

Where Hyatts turn at 40,000 rpm!

Old in theory, gas turbines are comparatively new as a practical power source. So it was big news in engine development when Solar Aircraft Company, of California, announced the world's first portable, hand-started gas turbine power plant.

Developing 50 horsepower, the new lightweight operates at the high speed of 40,000 rpm—or twenty times the speed of most automobile engines! And that's where *we* come in.

To be sure of complete bearing dependability for such high-speed operation, Solar turned to Hyatt . . . and there's a Hyatt Hy-Load Roller Bearing at the most critical position on the turbine shaft.

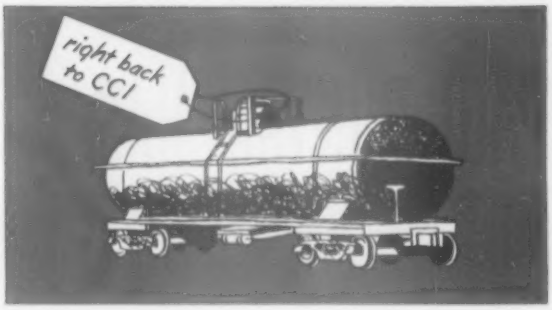
Whether you're building locomotives or lawn mowers, and whether shafts turn at 4 or 40,000 rpm, you'll get better bearing performance from *Hyatts!*

HYATT

ROLLER BEARINGS

STRAIGHT ○ BARREL ○ TAPER ○

HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION • HARRISON, NEW JERSEY



Sludge acid?

if you can pump it Consolidated can regenerate it!

THANKS to Consolidated's giant new regenerating facilities —even the muckiest sludge sulphuric acid no longer poses a disposal problem.

Regardless of hydrocarbon content—if your sludge is fluid enough to be pumped from the tank car, Consolidated can convert it into new, white acid.

Think of what this means to you in terms of convenience and savings: no disposal problem, no capital investment, no equipment maintenance, no waste.

Contract with Consolidated for regeneration of all your sludge acid. Only Consolidated offers this complete service.

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5326

PAUL BUNYAN HAS NOTHING ON YOU!

Yesterday, Paul Bunyan was a legend. Today he is you—and every other American.

Today you can travel as fast and as far as once upon a time only Paul Bunyan could travel. You can span a continent in hours. You can do even more. You can pull sleek streamliners over mountains. You can heat skyscrapers. You can build, lift, move, plow, kill insects, destroy weeds and grow crops—all through the use of petroleum products.

Every step in supplying you with needed petroleum products—finding new sources of oil, drilling, refining, transporting, distributing—is a big job.

Last year, for example, we invested more than $90,000,000 in the development of new sources of oil, including obtaining leases and drilling wells.

There are many other costly facilities too. A refinery of reasonable capacity and efficiency costs $25,000,000. One mile of pipeline may cost $35,000 or more to build today. And Standard Oil and its subsidiary companies have about 18,000 miles of pipelines. Other large amounts are required for expanded and improved marketing facilities—bulk plants, warehouses, service stations and motor equipment.

All told, to better serve civilian and military needs, our expansion and modernization program for 1954 and 1955 alone calls for capital expenditures of about half a billion dollars. Nearly half is going into development of new crude oil production and reserves.

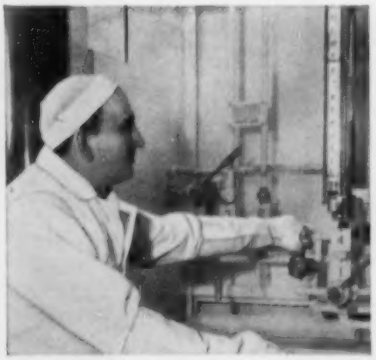
Modern equipment operated by skilled employees helps us to produce and deliver a gallon of gasoline at a remarkably low price. And two gallons today do the work that took three in 1925.

And because Standard Oil has grown with your ever mounting demand for petroleum, because we have big facilities and big resources, we are able to do a big part of the big job expected of industry in a nation of Paul Bunyans.

Standard Oil Company
(Indiana)

IF YOU HAVE VISITED Bemidji, Minnesota, you will remember seeing these giant statues of the legendary Paul Bunyan and Babe, the Blue Ox. Paul is symbolic of the American recognition that in a *big* country things have to be done on a *big* scale to meet a *big* demand.

IT TAKES BIGNESS in oil production to keep a mechanized nation moving ahead. Discovery of new sources of oil is vital. But drilling a wildcat well in an unproved area may cost more than a million dollars. And the odds are eight to one against finding oil in commercial quantities. Despite the cost and the risk, Standard Oil is constantly looking for and finding new petroleum sources to maintain the nation's reserves.



IT TAKES BIGNESS in research to keep up with the need for more efficient lubricants and fuels. A total of 2,700 people—men like Joseph J. Gregor of our Whiting laboratories—are employed in our research departments. In recent years we have plowed back about 66 cents out of every dollar of earnings in addition to borrowing over $300,000,000 to pay for expanded facilities, including research.

IT TAKES BIGNESS in planning to get ready for future demand. A 30,000-barrel-a-day refinery in which we invested millions of dollars has just been dedicated at Mandan, North Dakota. More millions are going into a major pipeline program. The investment of about 120,000 stockholder-owners—people like Mrs. Florence Luedeke Munro (above) of Peoria, Illinois—makes possible such huge building programs.

The chips that talk...

To the native savage, whose tribe had no conception of a written language, the piece of wood on which the explorer scribbled a message became the wonderful "chip that talks."

The chips of metal that pour in silver drifts from the mighty machines in Sun Ship's Wetherill plant tell their stories, too. Those shown on the 14-foot boring mill tell part of the story of a fast, thorough repair job on ship-propulsion machinery. That job required lifting a 54-ton section of crankshaft from the ship to a 10 ft. x 50 ft. engine lathe, where it was checked for trueness and the journals machined. The crankpins were machined in a huge crankshaft machine. The boring mill operation shown was the facing of the webs of a new section which replaced one of the damaged sections of the crankshaft.

That's the kind of story the versatile men and machines at Sun Ship have been writing for decades . . . in building special machinery of every type for the varied industries that are building a greater America.

Sun

SHIPBUILDING & DRY DOCK COMPANY

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Diamonds are a Girl's Best Friend...

BUT THE BEST FRIEND A

MUD PUMP

EVER HAD IS A SET OF

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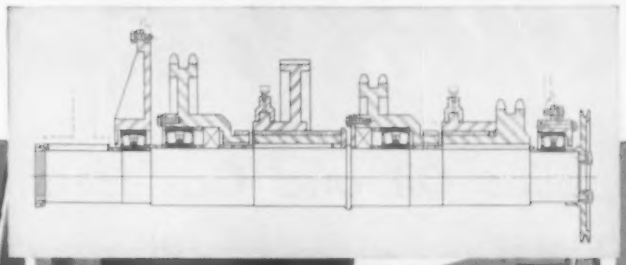
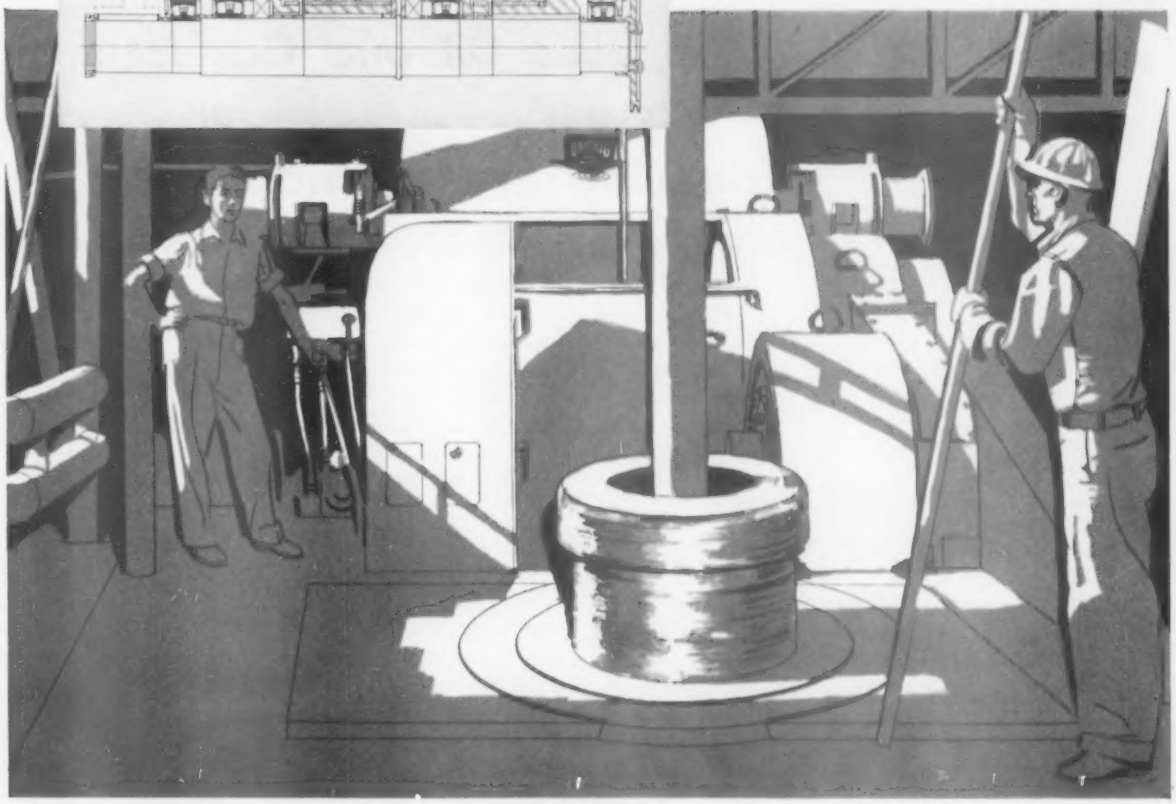
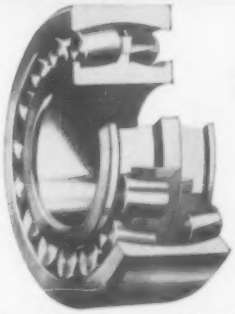
THE WORLD'S LARGEST INDEPENDENT OIL FIELD SUPPLY COMPANY



Precision-ground TORRINGTON Spherical Roller Bearings used on the input clutch shaft of the Unit Rig & Equipment Company's latest drilling rig—the Model U-40, help maintain long, trouble-free operation.



Long service minimum maintenance



Bearings for the input clutch shaft of the Unit Rig & Equipment's latest 6000′ to 10,000′ drilling rig—the 900 horsepower U-40—must be able to withstand the exacting demands of modern, competitive oil drilling.

That's why TORRINGTON Spherical Roller Bearings were used! And here's the reason . . . straight from the manufacturer himself:

"We use the TORRINGTON Spherical Roller Bearing because of its high capacity, long life, trouble-free operation, its ability to take thrust loads . . . and the one-piece cast-bronze cages which are an advantage in high-speed applications."

The accurate geometrical conformity between races and rollers permits maximum load bearing capacity at all times. The integral center flange on the inner race gives positive radial stability and positioning for thrust loads . . . both essential to satisfactory performance.

TORRINGTON Spherical Roller Bearings are available from stock with either straight or tapered bore, for shaft or adapter mounting.

THE TORRINGTON COMPANY
South Bend 21, Ind. Torrington, Conn.

District Offices and Distributors in Principal Cities of United States and Canada

TORRINGTON SPHERICAL ROLLER **BEARINGS**

Spherical Roller • Tapered Roller • Cylindrical Roller • Needle • Ball • Needle Rollers

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Supplies Oil and Gas Heat Transfer Equipment for . . .

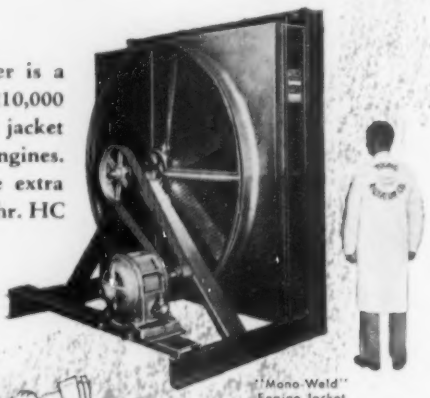
Condensing Steam and Vapors Cooling Oil, Water and Gases

Whatever your need for Heat Transfer Equipment in any phase of the Petroleum Industry, Young can supply modern, efficient cooling and condensing products. To further assist you, Young Radiator Company provides complete engineering and manufacturing facilities for custom building heating or cooling equipment to your specific requirements. For quick information on any Young product, see your nearest Young Representative listed below, or mail coupon to: **YOUNG RADIATOR COMPANY, Racine, Wisconsin**

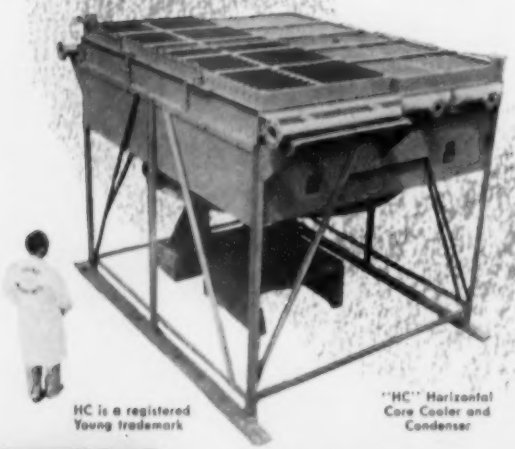
DRILLING

The "Mono-Weld" Engine Jacket Water Cooler is a Young-developed product built in capacities from 210,000 to 3,600,000 B.T.U. per hr. They provide efficient jacket water and fluid cooling of Diesel, gas and gasoline engines.

Young "HC" Coolers and Condensers provide extra large capacity cooling up to 11,000,000 B.T.U. per hr. HC units may be installed as single or multiple units.

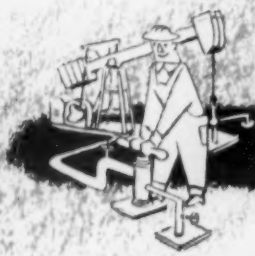


"Mono-Weld" Engine Jacket Water Cooler



HC is a registered Young trademark

"HC" Horizontal Core Cooler and Condenser



PRODUCTION

OIL FIELD REPRESENTATIVES

J. R. MEEK CO., 1341 S. Boston St., Rm. 109, Tulsa; J. R. MEEK, 3410 West Lamar, Houston, Texas • F. C. WALZ, 301 Irving St., Denver • FLOURNOY & EVERETT, INC., 9346 Stamps Ave., Downey, Calif. • HAROLD J. YOUNG, 206 Montgomery Bldg., Muskegon • JONES & LAUGHLIN STEEL CORP., Supply Div., 106 Main St., Bradford, Penn.; Union Commerce Bldg., Cleveland; 401 Liberty St., Gateway Center, Pittsburgh; Clarksburg, West Virginia. Other Representatives in Principal Cities.

YOUNG

YOUNG RADIATOR COMPANY

GENERAL OFFICES: RACINE, WISCONSIN, U.S.A.
PLANTS AT: RACINE, WISCONSIN, AND MATTOON, ILLINOIS

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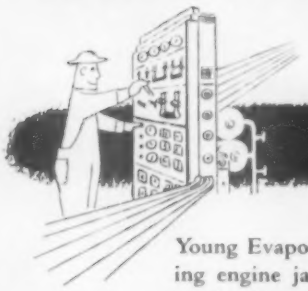
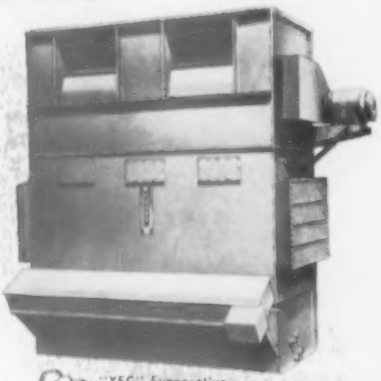


PIPELINES

Young Evaporative Type Coolers are engineered for cooling engine jacket water, lubricating oil, natural gas, and condensing steam, hydrocarbons and other vapors. Normal operating pressures: 100 psig for water and oil cooling; condensing pressures up to 2000 psig for steam or natural gas. Young Torque Converter Coolers are designed for any mobile or stationary application up to 600 hp. Stationary, mobile, air or water cooled types available.

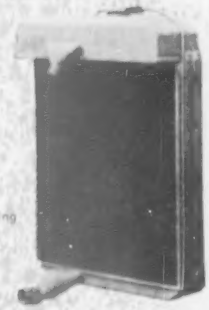


"YEC" Evaporative Type Cooler and Condenser

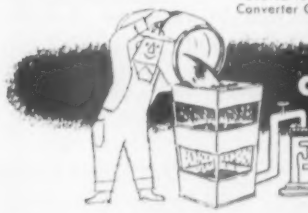
FIELD PROCESSING

Stationary Type Air Cooled Torque Converter Cooler

Shell and Tube Heat Exchanger

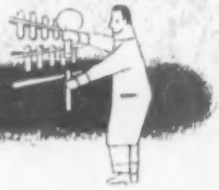


Engine Cooling Radiator



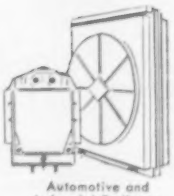
CRUDE REFINING

Young Shell and Tube Heat Exchangers can be furnished as standard models or specially designed for any kind of fluid-to-fluid cooling. Maximum operating pressures: 75 psi; temperatures up to 300 F. Young Engine Cooling Radiators are available with either stationary or removable one-piece cores . . . in sheet metal, cast iron and welded steel construction.



PETRO-CHEMICALS

Heating and Cooling Coils



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Unit Heaters

"YAC" Air Conditioners

Convector Radiators

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YOUNG RADIATOR COMPANY

Dept. 204-L, Racine, Wisconsin

Please send me the Young Catalogs checked below . . . without obligation.

- ☐ Young Engine Jacket Water Cooler Catalog
- ☐ Young Torque Converter Cooler Catalog
- ☐ Young "HC" Cooler and Condenser Catalog
- ☐ Young Shell and Tube Heat Exchanger Catalog
- ☐ Young Evaporative Cooler and Condenser Catalog
- ☐ Young Radiator Company General Catalog

Name_____

Title_____

Company_____

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City_____ State_____

GASO DISTRIBUTORS . . .
CHOSEN WITH CARE TO
take care of your needs

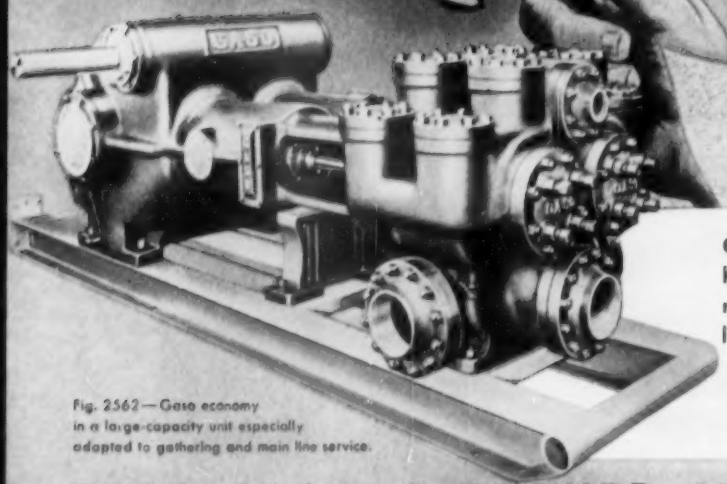

Fig. 2562—Gaso economy in a large-capacity unit especially adapted to gathering and main line service.

Gaso distributors, listed below, combine a first-hand knowledge of local conditions and requirements with a practical knowledge of the Gaso line. They are good people to know, helpful people to contact for a sound solution of any problem involving portable pumping units.

GASO PUMP & BURNER MFG. CO.

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EXPORT OFFICE: 149 Broadway, New York

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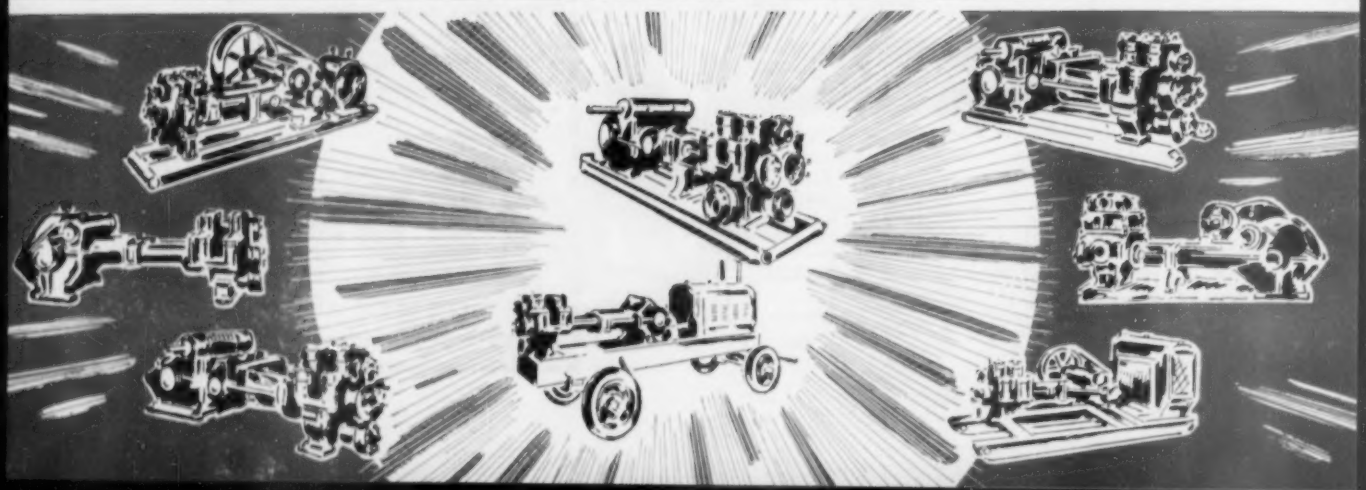
W. L. SOMNER COMPANY, Shreveport, Louisiana
Tinsley, Mississippi • Brookhaven, Mississippi • Odessa, Texas
POWER PUMPS, INC., Long Beach, Calif.
PEDDLERS, INC., Houston, Texas
NORTEX ENGINE & EQUIPMENT CO., Wichita Falls, Texas
LUFKIN FOUNDRY & MACHINE CO., Casper, Wyoming

GASO PUMPS

for every oil industry need



RECTOR type "M"

..the Tubing Head that's WAY ahead

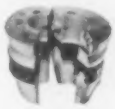
..in Flexibility

MANDREL HANGERS

Type "A" Mandrel Hanger threaded for EUE or regular tubing.

Type "M" Stripper for tubing heads with locking screws.

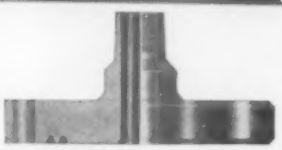
Type "A-O" Mandrel Hanger threaded, also grooved for locking screws. The "O" Ring serves as temporary seal.



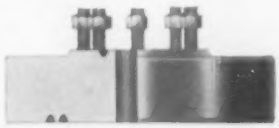
Type "WM" Wrap-Around Mandrel. It is hinged to wrap around tubing; also grooved for locking screws.

Type "C" "Slick Joint" Mandrel grooved for locking screws. The "O" Ring serves as temporary seal.

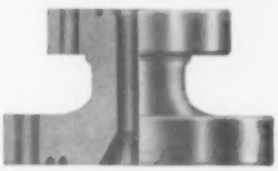
BONNETS



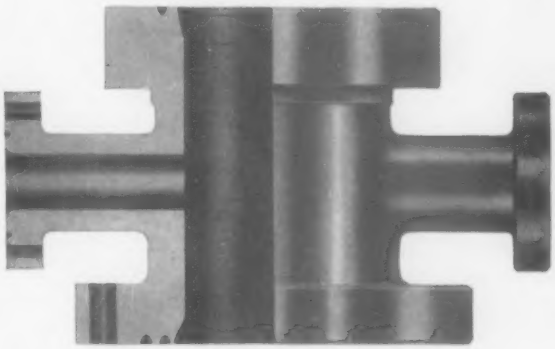
Male threaded bonnet also available with underside female threaded to hang tubing.



Studded bonnet also available with underside female threaded to hang tubing.



Spool-type bonnet also available with underside female threaded to hang tubing.



• The wide range of body types (6), the complete range of pressures (2,000 to 15,000 lb. test), the variety of mandrel hangers and bonnets (10) . . . all of which are interchangeable in the bodies, plus auxiliary equipment, make it possible to select a Rector Type "M" Tubing Head for every well completion condition and preference.

Every one of these heads employs the proven Rector principle of sealing with steel . . . a single API Ring Gasket acting dually as seal and hanger hold-down. There are no soft or resilient seals in these heads to deterioriate, burn out, freeze or contract in extremely low temperatures.

When planning well completions . . . specifying Christmas Trees . . . specify a Rector Type "M" Tubing Head for the utmost in safety and flexibility.

For complete specifications of all Type "M" Tubing Heads, Mandrels and Bonnets, see the Composite Catalog.

RECTOR WELL EQUIPMENT COMPANY INC

★ MAKING THE OIL INDUSTRY SAFER

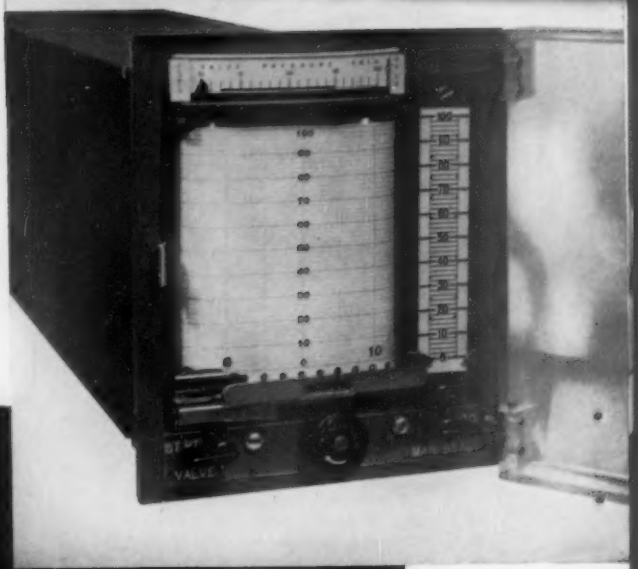
1100 NORTH COMMERCE ST. FORT WORTH, TEXAS

Houston Plant: 2215 Commerce St.

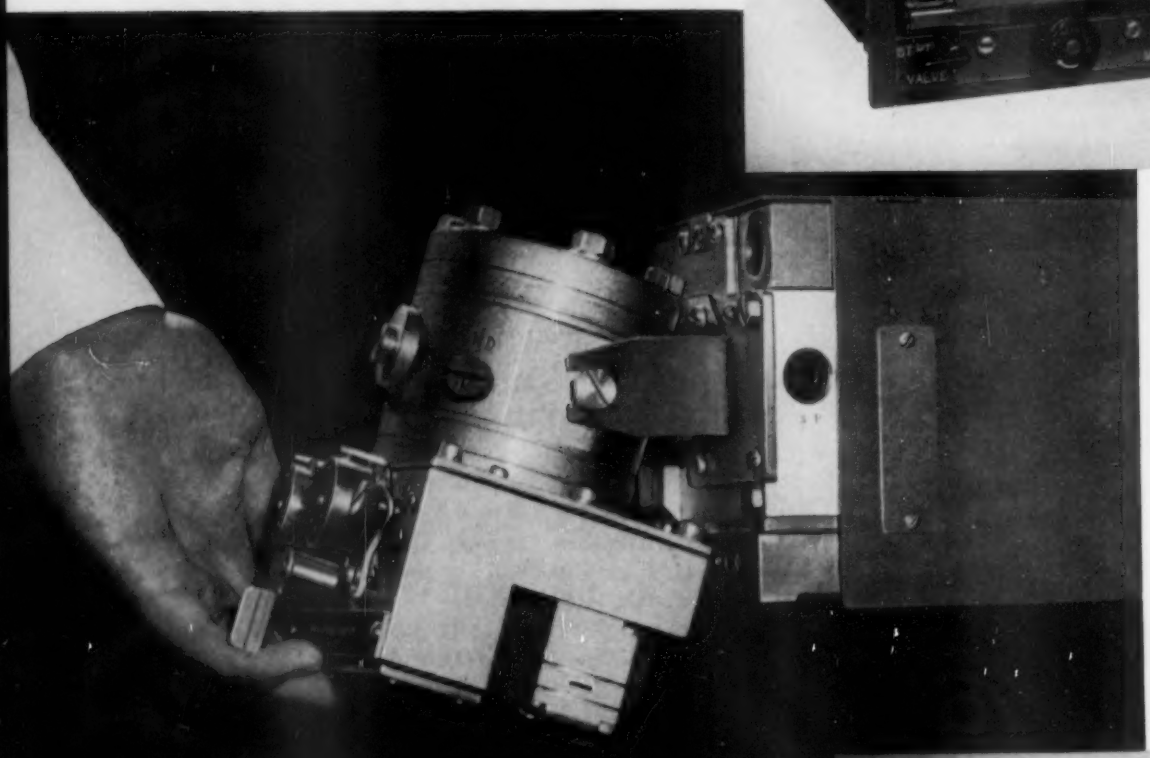
REPRESENTATIVES IN ALL ACTIVE FIELDS

RECTORHEAD RECTORSEAL

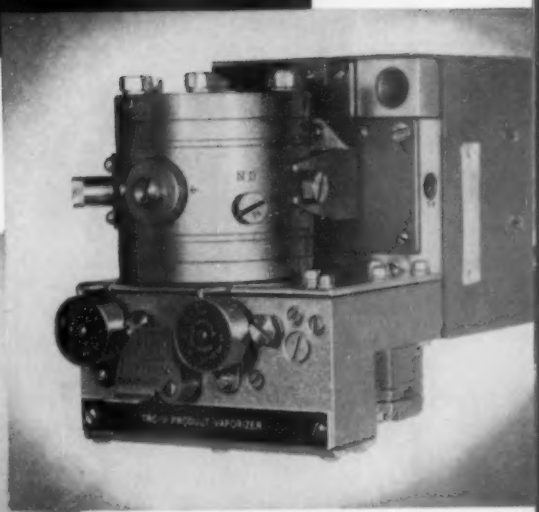
Horizontal scale above chart provides continuous indication of control air pressure to valve.

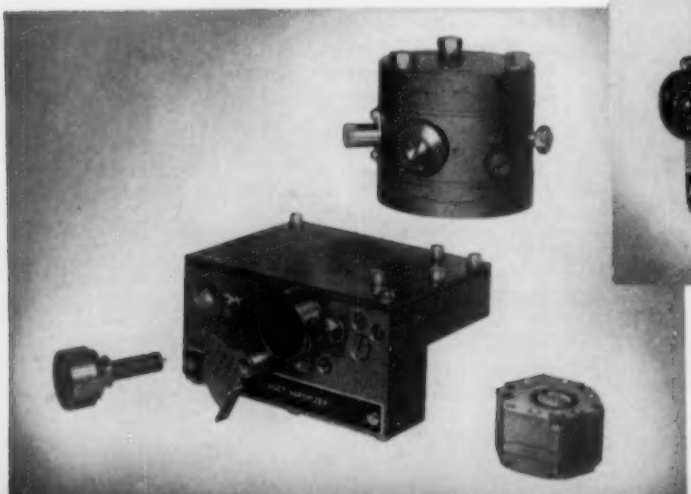


Quick-connect controller mounting . . . for added protection the controller is supported by a yoke when disconnected.



All adjustments are readily accessible from the rear of the controller.





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CASE HISTORY No. 534-224

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PERFORMANCE:
Tool Pusher J. E. Edwards reports, "These GM Diesels give us good, dependable, flexible service." With the "Quads" he can use from 2 to 16 engines to run his draw works or mud pumps, tailoring rig power to load demands.

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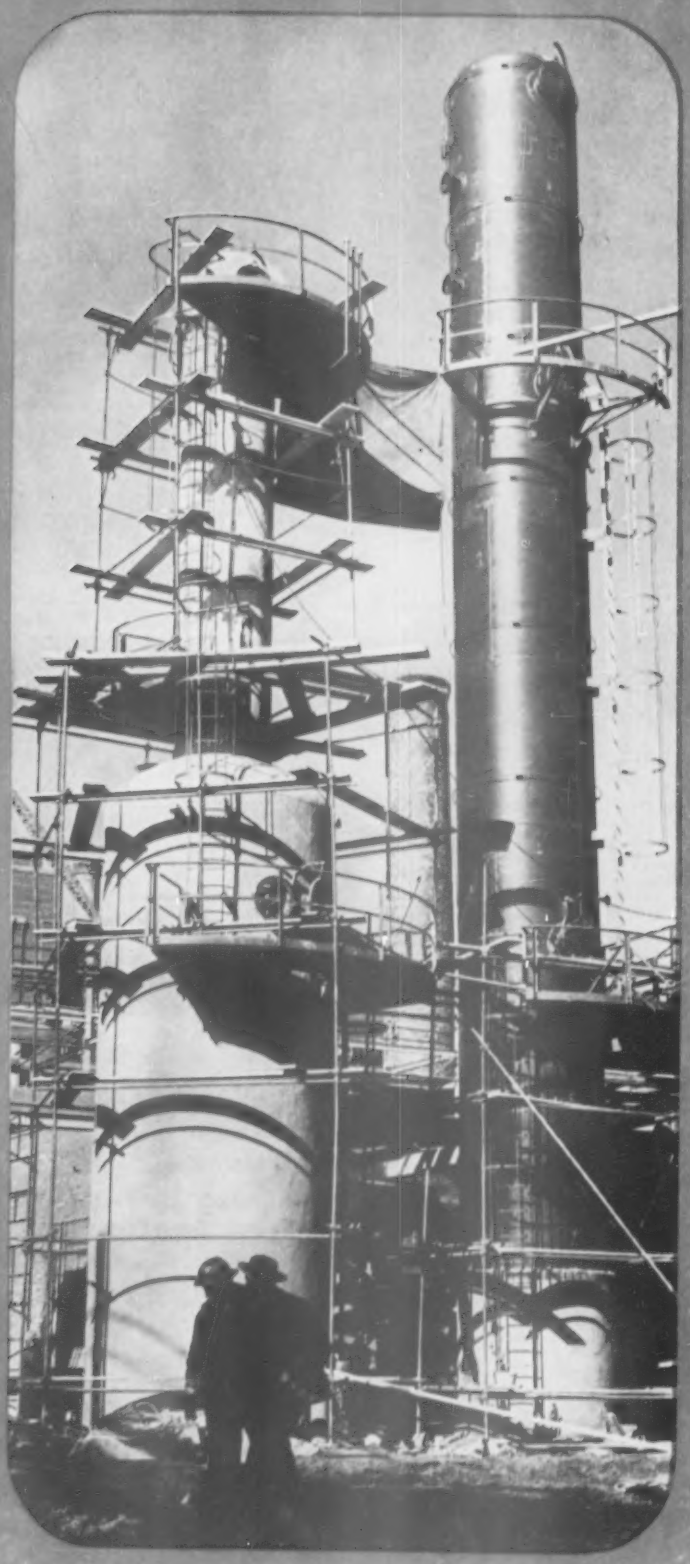

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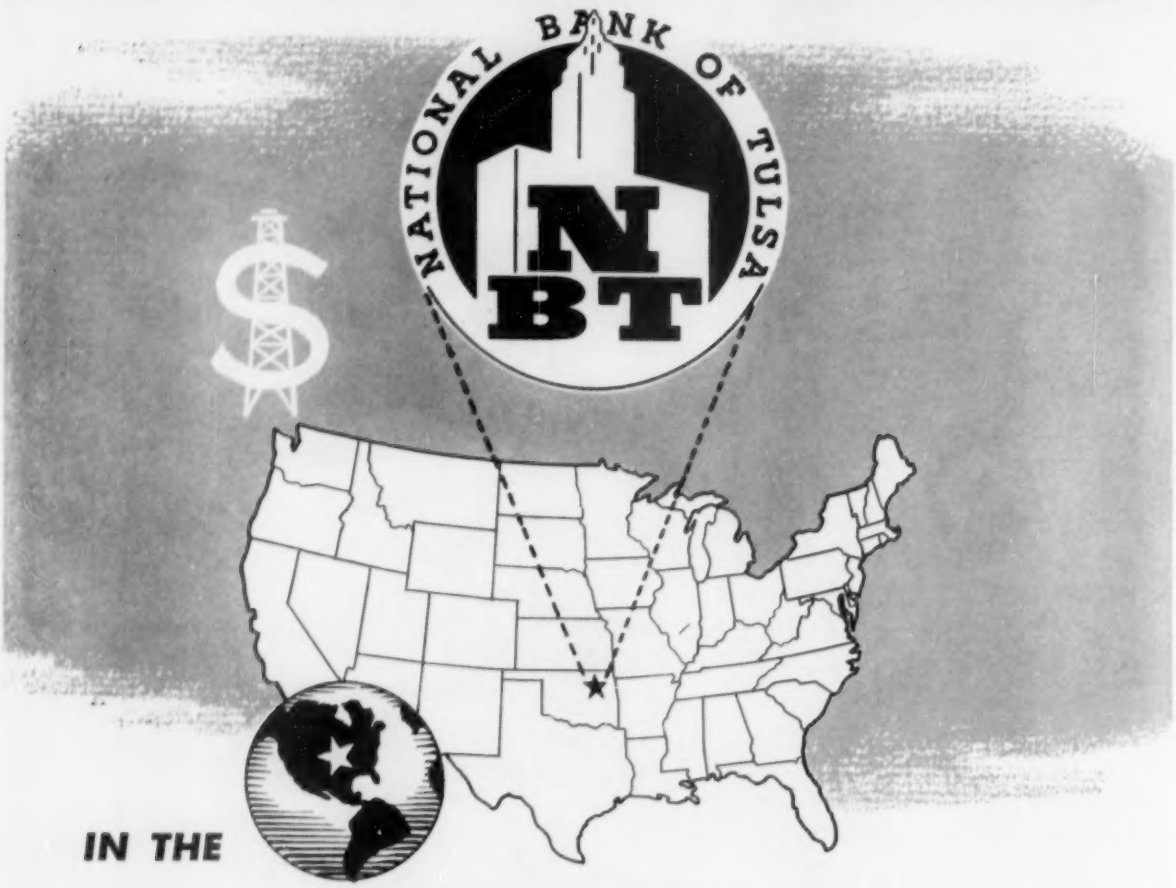

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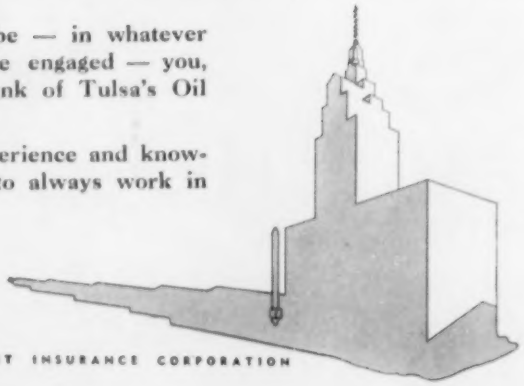

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YORK Technical Literature

1 Yorkmesh DeMisters, Entrainment Separators and Mist Eliminators

A bulletin describing the clean separation between liquid and vapor in all types of process vessels by means of Yorkmesh DeMisters. Information covers construction, types, applications, engineering data and installation instructions for improving the performance of vacuum towers, distillation equipment, gas absorbers, flash drums, knock-out drums, scrubbers, and evaporators through the use of wire mesh entrainment separators and mist eliminators.

2 Solvent Extraction

A bulletin presenting principles of operation, typical applications and engineering data on standard laboratory and pilot plant York-Scheibel multi-stage extraction units which are highly efficient and practical for both simple counter current and fractional liquid extraction.

3 "Performance of Wire Mesh DeMisters" by: Otto H. York

Reprint of paper presented before A.I.Ch.E. describing the performance of wire mesh demisters. Presents case histories from the chemical, petroleum and petrochemical industries which show how wire mesh demisters, are being used to eliminate overhead losses and increase the quality of the overhead product, while permitting operation at vapor velocities which would otherwise be excessive.

4 Bulletin 16 "Clean Separation with Yorkmesh DeMisters"

Bulletin 16 provides a detailed technical explanation with photos and schematic diagrams of the construction, types and applications of wire mesh demisters used to insure clean separation between liquids and vapors in vacuum towers, distillation equipment, gas absorbers, scrubbers, evaporators, knock-out drums and steam drums. Also included in this bulletin is a discussion of the York-Scheibel liquid-liquid Multi-Stage extraction column which is highly efficient and practical for both simple counter current and fractional liquid extraction.

5 Case Study 1001 "Entrainment Elimination Gives 31% Capacity Increase"

Detail case study showing how the installation of a stainless steel wire mesh section in an asphalt vacuum still at the Sinclair, Wyoming refinery of Sinclair Refining Company stopped entrainment and increased capacity. The account describes how the wire mesh installation was made and includes complete data on operating conditions before and after installation.

6 Case Study 1002 "Catalyst Poisoning Reduced 90%"

Case Study 1002 shows how the installation of a wire mesh demister pad in a vacuum tower supplying a substantial portion of the charge stock to several cracking units at General Petroleum Corp.'s Torrence refinery resulted in a 90% reduction in catalyst poisoning. Also included is a detailed description of tower operating conditions, the method of wiremesh installation and a table comparing metals content before and after the installation was made.

7 Case Study 1003 "Yorkmesh DeMister Eliminates Caustic Spray"

This case story contains reproductions of the initial correspondence, recommendations, order and service history exchanged through the mails by Otto H. York Co., Inc. and process engineers at a chemical plant troubled with a serious air pollution problem caused by the fine caustic spray rising from the open top of a scrubbing tower when operated at a steam rate of 3000#/hr. The correspondence reveals how a 6" demister section recommended by York completely eliminated the objectionable caustic spray.

8 Case Study 1004 "Vacuum Tower Capacity Increased 35%"

This case history shows how the installation of stainless steel wire mesh sections in two vacuum asphalt towers at Marcus Hook, Pa., refinery of Sinclair Refining Co. increased feed capacity 30-35% while maintaining gas-oil quality. Included in the account is a complete description of vacuum tower operation, a table of operating conditions and a comparison of operations before and after the demister installation. Also included is a diagram of the vacuum tower indicating the position of the wire mesh filter and the relative positions of the internal elements.

9 Case Studies 1005 and 1006 "Yorkmesh DeMisters Cut Compressor Maintenance"

Two case history accounts tell, respectively, how a monel wire mesh demister was installed in the compressor suction drum of a deasphalting unit at a Gulf Coast Refinery to reduce high maintenance costs on propane compressors; and how installation of a monel wire mesh demister pad in the compressor suction line of the catalytic cracking unit at a Midwest Refinery completely stopped the excessive maintenance which resulted from dilution of valve lubricants by liquids entrained in the gas stream.

10 "Calculation of Liquid-Liquid Extraction Processes" by: Edward G. Scheibel, Hoffmann-LaRoche, Inc.

Twelve page illustrated booklet with diagrams, charts and graphs, primarily concerned with coordinating existing information and presenting the simplest and most direct methods for the study and design of liquid-liquid extraction processes.

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A.P.I. RESEARCH PROJECTS

. . . Progress reports on some of the Institute's important activities

PROJECT 6

Analysis, Purification, and Properties Of Hydrocarbons

THE basic work of the A.P.I. Research Project 6, which is now in its twenty-eighth year of operation, is to learn what petroleum is chemically, i.e., of what individual hydrocarbon compounds or groups of related hydrocarbon compounds it is constituted. To achieve this goal of fractionation of hydrocarbons from petroleum, the project develops and operates fractionating processes to a degree of separating power much greater than is necessary in ordinary research operations.

To identify the hydrocarbon compounds isolated from petroleum in this way, the project requires highly purified compounds for comparison. To provide these reference samples, and at the same time to provide the samples needed by the laboratories of the petroleum industry for calibrating spectrometers, the project prepares highly purified hydrocarbons of the A.P.I. Research series, for fundamental-research measurements; and of the A.P.I. Standard series, for industrial or applied research, testing, analysis and control.

On the highly purified A.P.I. Research hydrocarbons, the project makes accurate measurement of the freezing point for determination of purity, and of the other physical properties important for record and identification.

Compounds prepared . . . A.P.I. Research Project 6 has had one well-selected representative petroleum under exhaustive fractionation continuously since 1928. To date, 141 different hydrocarbon compounds have been isolated from the project's large lot of one representative petroleum. As of June 30, 1954, the project had completed the purification of 226 A.P.I. Standard hydrocarbons and 228 A.P.I. Research hydrocarbons.

To learn how different petroleums vary in composition, the project some years ago completed a long, but less exhaustive, analysis of the hydrocarbons in the gasoline fraction of seven different, carefully selected, representative petroleums. These latter data permit translating the extensive results obtained on the project's one representative petroleum to other petroleums on which only a few key points of data need be known or obtained.

Adapted from report presented at national meeting, A.P.I., Chicago, November 8, 1954.

Fractionating Processes

The system of fractionating which has been developed by A.P.I. Research Project 6 may be described as the systematic interlocking of the appropriate fractionating processes. The order in which the various fractionating processes are used to separate a given fraction of petroleum into its main constituents is determined by the effectiveness of each given process in furthering the separation already attained by the preceding treatment.

General problem . . . The general problem of fractionation may be pictured in a simple manner, as follows:

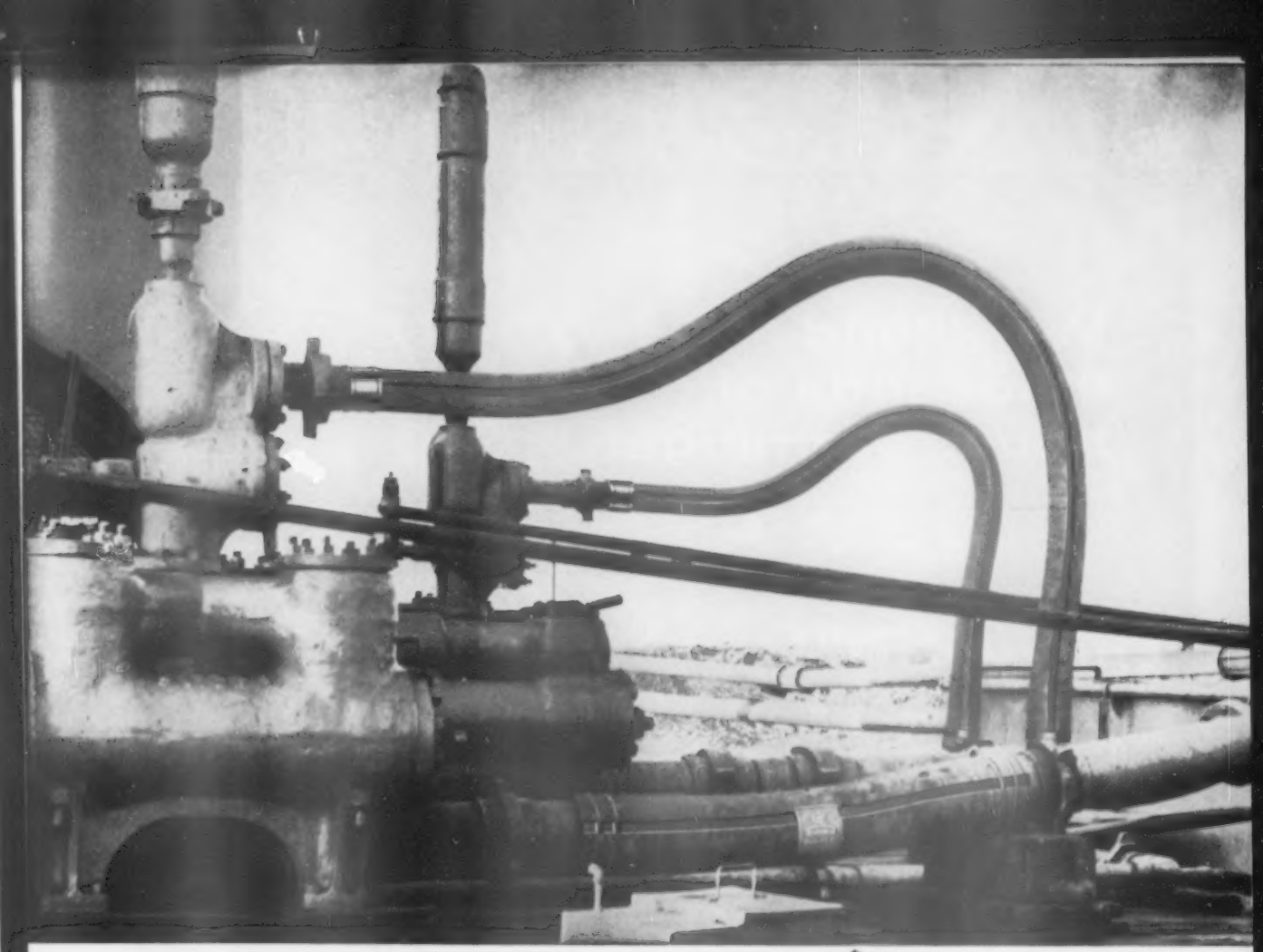
Suppose we have a mixture of two different molecules, MX and NY. We can subject this mixture to a set of physicochemical conditions such that two phases A and B—including any combination of gaseous, liquid, or solid phases—are established in thermodynamic equilibrium with each other.

If it turns out that the ratio of the mole fraction MX to that of NY is different in one phase from that in the other phase, and consequently both are different from the ratio in the original mixture, then the given set of physicochemical conditions may serve as the nucleus of a fractionating process for the mixture. A simple example of such an experiment would occur if the original liquid mixture of MX and NY were subjected to conditions producing two phases, liquid and gaseous, in thermodynamic equilibrium, and if one of the components was found to be more abundant in the gaseous phase than in the liquid phase.

The material in the gaseous phase could then be taken to produce a second stage of the process, yielding a new liquid phase in equilibrium with a new gas phase, in which a proportional enrichment of the more volatile component would occur. Repetition of this operation would yield a multistage process for fractionating by distillation.

Equilibrium . . . The foregoing fractionating processes involve a thermodynamic equilibrium between two phases, in which the molecules are continually passing back and forth between the two phases. Another kind of fractionating process is one involving differences in the rate of escape of the two kinds of molecules from one phase into a second phase without return to the first phase.

An example of this type of fractionating process is that of molecular distillation, involving a liquid phase and a gaseous space in which the concentration of molecules is practically



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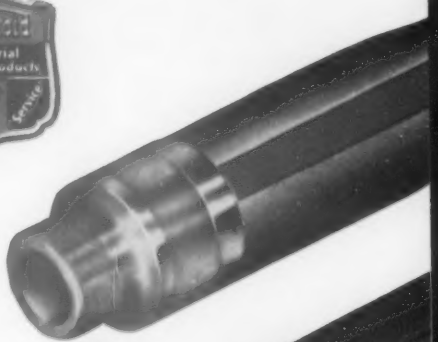
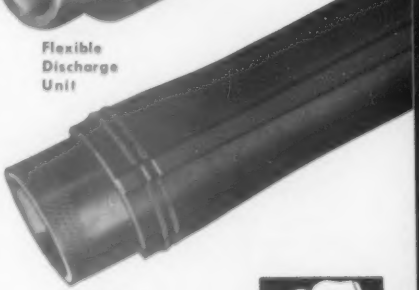


Flexible Discharge Unit



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zero. The fractionation in such a process occurs by reason of differences in the rate of escape of the two kinds of molecules from the liquid phase into the evacuated gas space, which evaporation depends upon the molecular weight and volatility of the components.

Another example of a fractionating process depending upon rate of movement of molecules from one phase to another is that of diffusion from one gas phase into a second gas phase, through a membrane or other barrier of extremely small passages.

Properties . . . In order to measure the extent or degree of separation attained with a given fractionating process, and to mark the course of the separation occurring in a systematic series of fractionating operations, appropriate properties—capable of being measured conveniently—are determined on each of the fractions of material issuing from the fractionating process. The properties so measured should be ones which have significantly different values for the components of the mixture being separated.

The separation of aromatic hydrocarbons from cycloparaffin or paraffin hydrocarbons can be conveniently marked by measurement of the refractive index. The same property may be used to mark the separation of paraffin hydrocarbons from cycloparaffin hydrocarbons of the same boiling range. Density is a property which may be similarly used, although it is not conveniently measured.

When distillation is used as a fractionating process, and the boiling point of the distillate is measured during the distilling operations, the boiling point may be used conveniently to mark the course of the separation of components which do not form constant-boiling mixtures.

Isomer separations . . . When isomeric hydrocarbons of nearly the same boiling point are being separated, properties such as boiling point, refractive index, and density are of little value in marking the separation. In such cases the property of the freezing point may be used, or spectrographic analysis, based upon calibrations using pure samples of all the possible components, may be employed.

When the fractionation is one of separating unknown minor components from a known major component—as in the purification of a substance—the freezing point appears to be the only property safe to use.

In general, if the components being separated are fully known, short-cut methods involving spectrographic analysis may frequently be used with most satisfactory results, provided adequate standard samples are available for calibration.

Fractionating processes involving thermodynamic equilibrium between two phases include distillation, extraction, absorption, and crystallization. Each of these has one or more variations.

Regular Distillation

Regular distillation is the most commonly used fractionating process for separating and purifying substances which are liquid and stable at the temperature of distillation. In the work of the A.P.I. Research Project 6 distillation has been by far the fractionating process used most.

The requirements of this project for distilling operations of high efficiency for the purpose of separating hydrocarbons from petroleum, for analyzing mixtures of petroleum hydrocarbons, and for purifying A.P.I. Standard and A.P.I. Research hydrocarbons have been such as to necessitate the continuous operations, 24 hours per day, 7 days per week, of 10 to 15 distilling columns.

Azeotropic Distillation

When a substantially constant-boiling mixture of hydrocarbons contains components whose vapor pressures are affected differently by the addition of a nonhydrocarbon compound, the distillation of the hydrocarbons with the added compound my serve to separate the hydrocarbon components.

In azeotropic distillation the added compound is of the same general volatility as the compounds to be separated, and consequently can be introduced into the pot with the original charge.

A further important advantage of azeotropic distillation is that any excess of the added substance may be used so that none of the wanted substances being separated need remain as holdup or residue in the distillation column, but can all be taken overhead in the azeotropic distillate.

One characteristic feature of the temperature-composition diagrams for those systems forming azeotropic mixtures is that, except near the composition of the constant-boiling mixture, the spread in composition between the liquid and vapor phases is usually much greater than it is in systems that do not form azeotropic mixtures.

With some exceptions nearly all polar organic molecules of the proper volatility form, with hydrocarbons of the paraffinic, cycloparaffinic, aromatic, and olefinic classes, mixtures that have a total vapor pressure greater than that of the more volatile pure component, yielding minimum-boiling azeotropic mixtures.

The organic compounds that form azeotropic mixtures with these hydrocarbons include those containing hydroxl, carboxyl, cyanide, amino, nitro, and other structural groups that tend to produce polarity in organic molecules.

Possible separations . . . From the data that are now available, the following conclusions may be drawn with regard to the separations obtainable by azeotropic distillation in distillation columns having separating efficiencies up to 200 equivalent theoretical plates:

1. Aromatic hydrocarbons may be separated from cycloparaffins and paraffins with relative ease by one appropriate azeotropic distillation in an efficient rectifying column, in mixtures in which the aromatic hydrocarbons normally having boiling points not significantly lower than the boiling points of the cycloparaffins and paraffins in the given mixtures.

2. Cycloparaffin hydrocarbons may be separated from paraffins by one or more distillations with an appropriate azeotrope-forming substance in an efficient rectifying column, in mixtures in which the cycloparaffin hydrocarbons normally have boiling points not significantly lower than the boiling points of the paraffins in the given mixtures.

3. Aromatic hydrocarbons of different degrees of "aromaticity" resulting from different numbers and kinds of rings, as for example an alkyl benzene, an alkyl tetrahydronaphthalene, and an alkyl naphthalene, may be separated from one another, in mixtures in which the various aromatic hydrocarbons have substantially the same normal boiling points, or in which any differences in boiling point are of the same magnitude and sign as the differences in the boiling points of the corresponding binary azeotropic mixtures.

Such separations may require one or more azeotropic distillations in an efficient rectifying column, depending upon the nature of the components of the mixture and its complexity.

4. Cycloparaffin hydrocarbons having different numbers of cycloparaffin rings in the molecule may be separated from one another in mixtures in which the various cycloparaffin hydrocarbons have substantially the same normal boiling points or in which the cycloparaffins with two rings have boiling points not significantly lower than the boiling points of the cycloparaffins with one ring.

Several azeotropic distillations in an efficient rectifying column usually will be required for the substantially complete separation of such compounds.

5. Monoolefin hydrocarbons may be separated with relative ease from aromatic hydrocarbons, from paraffin

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hydrocarbons, and perhaps as easily from diolefin hydrocarbons.

Distillation at Different Pressures

When a mixture of hydrocarbons contains components which have substantially the same boiling point at the normal distilling pressure, but significantly different boiling points at a different pressure, the separation of such components can be effected by distilling the mixture alternately at the two pressures.

This procedure, which has had wide application in the work of the A.P.I. Research Project 6, has been particularly useful in separating cycloparaffins from paraffins, which two classes of hydrocarbons are normally quite difficult to separate. The procedure also may be used to separate mononuclear from dinuclear aromatics.

As the pressure is reduced, the average cycloparaffin hydrocarbon becomes relatively more volatile than the average paraffin hydrocarbon which has the same volatility at the first pressure, and similarly for the dinuclear aromatics referred to the mononuclear aromatics. The κ tables of the A.P.I. Research Project 44 contain a considerable amount of data on the boiling points at different pressures of many different hydrocarbons.

Distillation at Very Low Pressures

The experience of the A.P.I. Research Project 6 has indicated that prolonged stay at temperatures above 200°C. will cause significant decomposition of hydrocarbons. To avoid such decomposition the regular distillation of hydrocarbons normally boiling above 200°C. must be performed at pressures below 1 atm.

This is easily accomplished in the regular distilling operations of the project because each distillating column is provided with a connection to several different controlled constant pressures ranging from 760 down to 30 mm. of mercury. At the latter pressure hydrocarbon material normally boiling near 300°C at 1 atm. boils at a temperature near 185°C.

Extraction

The fractionating process of extraction has been used extensively by A.P.I. Research Project 6 in the resolution of the lubricant fraction and, to a lesser extent, the kerosine fraction of petroleum. Extraction separates primarily by molecular type, although some fractionation by molecular size also may occur. However, in practice the latter is not important because fractionation primarily according to molecular size is accomplished more easily by regular distillation.

The separations by molecular type for which the process of extraction is used include: (1) the separation of aromatics from paraffins and cycloparaffins; (2) the separation of mononuclear, dinuclear, and trinuclear aromatics from one another; (3) the separation of paraffins from cycloparaffins; and (4) the separation of monocycloparaffins, dicycloparaffins, and tricycloparaffins from one another.

Adsorption

Beginning with some very simple laboratory experiments in 1934, the A.P.I. Research Project 6 has developed the fractionating process of adsorption as a powerful tool in its work on the separation and analysis of hydrocarbons.

The principal applications of the process include the separation of aromatic hydrocarbons from paraffin and cycloparaffin hydrocarbons; the separation of mononuclear aromatic hydrocarbons from polynuclear aromatic hydrocarbons; and the separation of olefin hydrocarbons from paraffin, cycloparaffin, and aromatic hydrocarbons.

For the separation of aromatic hydrocarbons from paraffin and cycloparaffin hydrocarbons the process of adsorption is effective with material

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Adsorption may also be used for the separation of nonhydrocarbon materials—principally oxygen, sulfur, or nitrogen compounds—from hydrocarbons occurring in petroleum.

Basic principles . . . Fractionation by adsorption is subject to the basic principles of fractionation. The phases involved in the fractionation may be "solid adsorbed" and liquid, or "solid adsorbed" and gaseous. Each phase may consist only of the substances being fractionated or of these with an added substance which affects the relative escaping tendency of the molecules.

When no added substance is present, the fractionation may be termed regular adsorption, analogous to regular distillation. When the added substance occurs in significant amount in both phases, the fractionation by adsorption will be analogous to fractionation by azeotropic distillation.

When the added substance occurs in significant amount in one phase only, the fractionation by adsorption will be analogous to fractionation by extractive distillation.

When the phases involved are a solid-adsorbed phase and a gaseous phase, the transfer of material from the solid adsorbed phase to the gaseous phase is effected by application of heat, whereas the transfer of material from the solid-adsorbed phase to a liquid phase is effected by a desorbent which is very much more strongly adsorbed than any of the components in the fractionating system.

The separation factor α may be evaluated either from static experiments in which the adsorbed and liquid phases are equilibrated through an intervening gaseous phase, or from fractionating experiments performed in columns packed with adsorbent.

Crystallization . . . The fractionating process of crystallization holds great attraction because of the fact that for many systems it is possible to have a separation factor of infinity, so that theoretically one may obtain one of the components in a pure state with one stage of separation. In such systems the solid crystalline phase is one pure component. However, even when the solid crystalline phase is a mixture of two components, the separation factor, although far from being infinite as in the ideal case, is frequently large enough to bring about large changes of composition in a few stages of separation.

In the work of A.P.I. Research Project 6 fractionation by crystallization has been used both for the separation of pure compounds from fractions of petroleum and for the preparation of hydrocarbons of high purity. Before using the process of crystallization, it is usually necessary to have highly concentrated the individual component to be crystallized out.

Solid Molecular Compounds

A solid molecular compound results when two or more different kinds of molecules become firmly held together, without the operation of strong chemical forces such as ionic or homopolar bonds. Both the formation of solid molecular compounds and their decomposition into their constituent molecules depend upon the environment and the temperature.

Large concentrations of the components and low temperatures favor the formation of solid molecular compounds, whereas small concentrations and moderately elevated temperatures favor the regeneration of the constituents. The formation of solid molecular compounds, coupled with the regeneration and recovery of the components, provides the basis of fractionating methods which are effective for separation of various chemical substances including hydrocarbons.

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PROGRESS REPORT: A.P.I. Research Project 42

High-Molecular-Weight Hydrocarbons in Petroleum

RESEARCH Project 42 prepares, purifies, and studies the properties of model hydrocarbons in the lubricating-oil range to afford a better understanding of the behavior of oils.

In order to prepare the hydrocarbons for study the project must devise suitable methods of synthesis and purification. In the course of this work certain guiding principles have been established, and special apparatus and methods have been developed.

The properties of an oil are summations of the properties of the individual chemicals which comprise the oil. The properties of these individual chemicals, principally hydrocarbons, are determined by the architecture of their molecules.

Project 42's primary objective is a better understanding of the effects of these molecular features on properties, which must lead to a better understanding of why oils behave as they do. The availability of pure hydrocarbons of known structure is essential to such a study, and Project 42 has and must devote much effort to the preparation and purification of the hydrocarbons selected.

Problems in Synthesis

Because of the difficulties in the high-molecular-weight range previous workers sometimes have gone astray and care must be taken to avoid the pitfall of misleading literature.

Careful study frequently is needed even when satisfactory methods appear to be available from the literature.

The problem of competing reactions which can lead to products other than the desired one is often severe, and always must be given careful consideration because byproducts produced by concomitant side reactions may have physical properties not far removed from those of the desired products, making separation by physical processes difficult or impossible. In some cases competing reactions greatly reduce or completely eliminate the yield of desired product.

Dehydration . . . Since many of the hydrocarbons are prepared by catalytic hydrogenation of olefins produced through the dehydration of alcohol intermediates, care must be taken to avoid possible competing reactions during the dehydration step. With some molecular arrangements these may lead to isomerization of the olefinic linkage, rearrangement of the carbon skeleton, or the like.

Hydrogenation is one of the most useful tools of synthetic organic chemistry, and has been widely used by Project 42 in hydrocarbon preparation. The problem of competing reactions is sometimes severe in catalytic hydrogenation, especially when a particular unsaturated linkage is to be reduced selectively.

Many of the aromatic hydrocarbons prepared at Pennsylvania State University involve the selective hydrogenation of carbon-carbon double bonds in the side chains of molecules containing aromatic nuclei.

Problems in Purification

Products direct from synthetic organic reactions are never pure; rather, they always contain traces of the starting materials, as well as byproducts produced by reactions concomitant with the desired one, and must be purified. Careful choice of synthetic route is important in order that such impurities may be removed by available purification methods.

Most purification techniques are fractional physical-separation processes such as distillation, crystallization, adsorption, and the like, which depend for separation power and efficiency on the differences between certain physical properties of the impurities and the desired product.

At the higher-molecular-weight levels differences in physical properties resulting from differences in structure tend to be minimized because a lesser proportion of the larger molecule is changed by a given modification in structure than at the lower-molecular-weight levels.

Distillation . . . Distillation through fractionating columns is the most useful purification tool employed by Project 42. At high molecular weight the distillation problem becomes complicated by the high boiling point of the hydrocarbons. Since subjection to such temperatures would result in thermal cracking, distillations of these high-boiling materials must be conducted at reduced pressure.

In order to minimize the possibility of thermal effects, such distillations are conducted at between 0.5 and 1.0 mm., thus keeping still temperatures low enough to make distillation practical as high as C_{40}. But the need for operation at very low pressures greatly complicates the design of fractional distillation columns.

The highly efficient packed fractionating columns employed for purification of the lower-boiling intermediates cannot be used for the high-molecular-weight products since these packed columns have an operating pressure drop across the rectifying section of the order of 10 to 20 mm. and, therefore, even if the pressure at top of the column is maintained at 1.0 mm., the pressure in the still would be of the order of 10 to 20 mm. Thus the still temperatures would be too high, and efficient operation very difficult because of the large temperature gradient between the bottom and the top of the fractionating section.

For these reasons Project 42 and others have had to develop special fractionating columns for purification of the high-molecular-weight products by distillation at low pressure. To avoid the difficulties of high pressure drop, the rectifying section of these special columns can only be slightly modified open tubes. Special operational techniques were early adopted which minimize the very high vapor velocities accompanying a reasonable distillation rate. Without the low-pressure fractional distillation equipment which was developed, the accomplishments of the project to date would have been impossible.

Nearly all of the final hydrocarbons reported thus far were purified by fractional distillation in a column having an efficiency of 7 to 10 theoretical plates. Study of fractionating-column design for low-pressure operation has been continued through the years, and the project recently has developed a column with a 6-ft. rectifying section having 18 to 20 theoretical plates at 1.0-mm. pressure.

Crystallization . . . Though sometimes invaluable, fractional crystallization as a separation process is, in general, much less useful for the purification of higher hydrocarbons than is fractional distillation for several important reasons. First, many of the high-molecular-weight hydrocarbons crystallize at such low temperatures that recrystallization techniques are impractical with current

Adapted from report by R. W. Schiessler, Pennsylvania State University, State College, Pa.; and H. Sutherland, Shell Development Co., New York. Report presented at national meeting, A.P.I., Chicago, November 8, 1954.

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A.P.I.—Research Project

equipment, or crystallize very slowly due to high viscosity. Second, fractional recrystallization frequently is wasteful both of time and material since much handling is required.

Furthermore, impurities closely similar in structure to the desired product often form solid solutions with the latter, producing additional complications. In some cases, however, fractional recrystallization is very powerful and may be superior to any other purification process available.

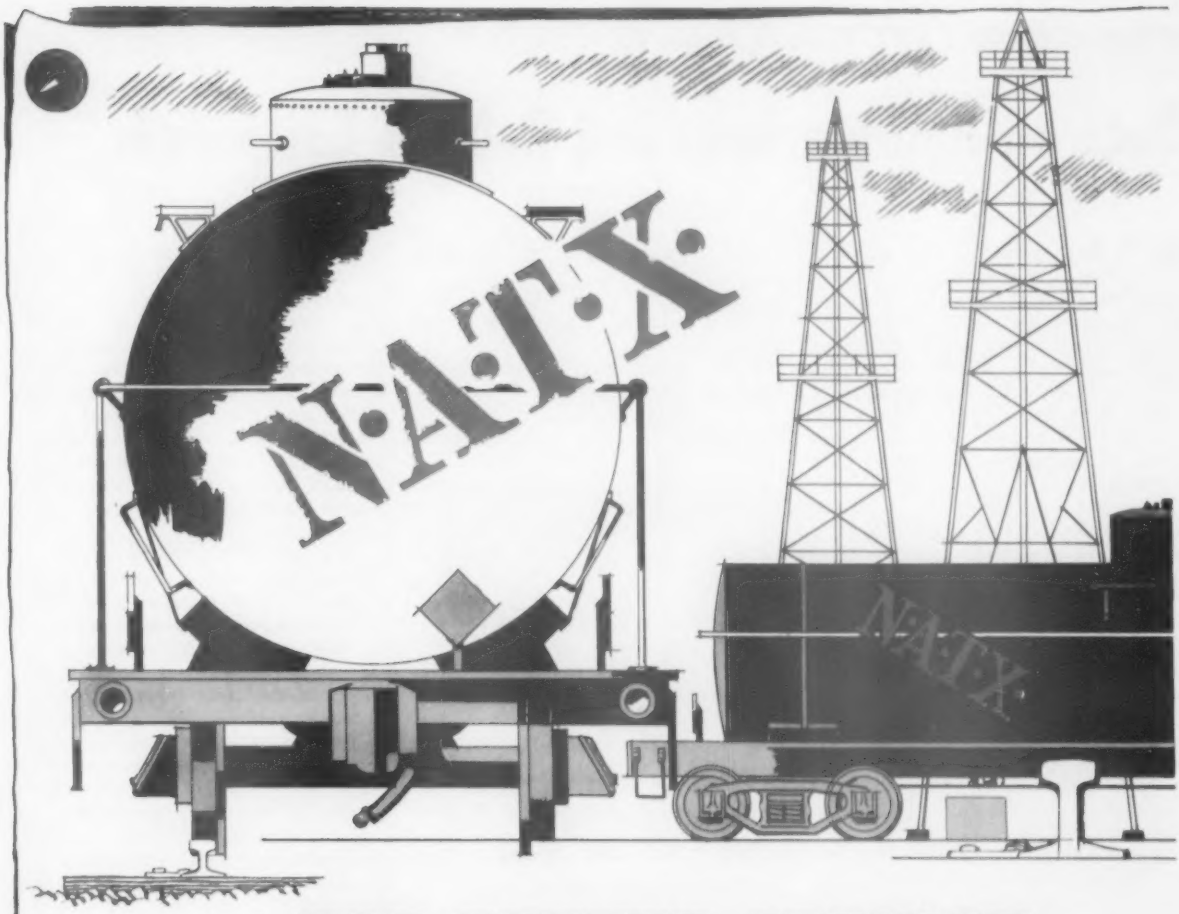
Adsorption . . . For the removal of trace impurities, particularly of the polar type such as alcohols, ketones, esters, and the like, fractional adsorption using columns packed with silica gel or activated alumina is a very efficient technique. All of the high-molecular-weight hydrocarbons have been so treated once, and most hydrocarbons were given several adsorption treatments during purification processing.

The removal of such trace impurities is especially important for samples which will be submitted to infrared, ultraviolet, and mass-spectroscopic examination. Even for hydrocarbon impurities closely similar in structure to the desired hydrocarbon, there is a good chance of separation by passage over silica gel because such mixtures frequently show such adsorption behavior that the adsorbent prefers the component contained in lowest concentration in the mixture, a curious but very useful phenomenon.

Current research at Pennsylvania State University is aimed at establishing the effect of molecular structure on relative adsorptivity and adsorbent capacity. The early results indicate that these studies will be useful in guiding the design of future adsorption separation techniques.

Complexes . . . The new separation processes based on the formation of crystalline complexes with urea and thiourea are proving valuable where applicable. The formation of these complexes depends upon the shape and dimensions of the hydrocarbon molecule, and has been studied to some extent by Project 42.

In special cases products are given chemical treatments which selectively modify the chemical nature of expected impurities so that separation processes will function more efficiently. Of course, great care must be taken in choosing such a chemical treatment to avoid any possibility of modifying the molecular structure of the desired hydrocarbon.



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PROGRESS REPORT: A.P.I. Research Project 44

Data on Hydrocarbons and Related Compounds

RESEARCH PROJECT 44, which is now in its thirteenth year of operation, serves as the central agency of the American Petroleum Institute for collecting, calculating, and compiling basic scientific data of interest and importance to the petroleum industry.

The work covers physical, thermodynamic, and spectral (infrared, ultraviolet, raman, and mass) properties of hydrocarbons and related compounds. The over-all purpose of the project is to prepare and maintain up to date a complete set of such fundamental data, critically selected, internally consistent, and compiled in a convenient form for ready use.

Data usage . . . The availability of a complete set of tables of fundamental data relating to petroleum-derived components permits the petroleum industry to utilize its raw material to the greatest possible technological advantage. The data on physical properties help in identifying petroleum fractions as well as individual components. The data on infrared, ultraviolet, raman, and mass spectral properties help in making spectrographic analyses of plant streams and product materials in refining processes.

The data on thermodynamic properties permit the making of reliable thermochemical and thermodynamic calculations involving heat balances, energy requirements, P.V.T. and related properties, and chemical equilibria among the substances which are reactants or products in the refining processes.

The A.P.I. sends complete sets of these data gratuitously to universities, free libraries, nonprofit research institutions, and government organizations throughout the entire United States and in 26 foreign countries.

Aims of the Work

The aims of the project are as follows:

1. To examine all the pertinent original data in the literature, plus all available unpublished data, and to appraise them critically.

2. To correlate values of given properties, with temperature or pressure to obtain values for temperatures or pressures for which no data are available, and with molecular structure to obtain values for compounds for which no data are available.

3. To make original caluculations of thermodynamic and physical properties as necessary.

4. To select and tabulate "best" values of the properties.

5. To prepare the selected values in a convenient form for use by industrial and scientific laboratories.

6. To publish descriptions of the original calculations and correlations.

7. To keep the tables of selected values of properties up to date with revisions at appropriate intervals.

A large number of physical, thermal, and thermodynamic properties are being investigated.

The compounds covered or to be covered in the work of the project include hydrocarbons of all types and molecular weights, and nonhydrocarbon compounds of importance to the petroleum industry. The latter include organic sulfur compounds, organic oxygen compounds, certain nitrogen compounds, and certain halogens and halogenated hydrocarbons.

Location, Collection, and Recording

Data on physical and thermodynamic properties are found scattered through the entire scientific literature of chemistry, physics, and engineering. The staff has the responsibility of locating and collecting the original data of each investigator who has ever measured and published any desired property of any of the many compounds in the program.

With regard to such published literature, in any journal, however obscure, the first step is to find a reference to the original paper. Then comes the getting of the journal in which the publication appears. Then follows careful examination of the original paper, from which is extracted, in a standard form, an accurate record of the basic quantities actually measured by the investigator, not what he may have calculated or derived.

For each such publication a separate card of data is made for each different property for each different compound measured. That is to say, if a given publication deals with experimental measurements on 5 different properties and 20 different compounds, a total of 100 different cards of data are made from this one paper alone. Only in those rare cases where the original paper cannot be obtained by the project are data ever used which are not taken directly by the staff from the original paper.

The extent of the coverage of the scientific and technical literature by the project is indicated by the fact that the number of papers included in the list of references is now approximately 3,000. The total number of individual cards of data now in the files of the project is about 600,000.

Data Handling

The information normally recorded on the individual cards of data includes the following: name of the compound; the property involved; the names of the authors, with complete journal reference; the quantities actually measured by the investigator and their numerical values; the mode of preparation of the compound, and information as to its purity; the nature and calibration of the system for measuring temperature, or pressure, or energy, or time, or length, or volume, or mass, as appropriate, and the actual units employed in such measurements.

Appraisal must be made not only of the real accuracy of the physical measurements but also of the purity of the substance on which the measurements were made. Categorical limits cannot be set on the permissible amounts of impurity in the compounds measured. For some properties, such as boiling point, or refractive index, or density, astonishingly large amounts of isomers which have themselves nearly the same value of boiling point, or refractive index, or density, respectively, can be tolerated with little effect on the measured value. For other properties, however, such as freezing point, even minute amounts of any impurity will be significant.

Selection of values . . . For the simple physical properties of the more common compounds many sets of numerical values may be available. The selection of a "best" value in such cases cannot be done by the simple process of averaging the available values. Some values must be ruled out because of inadequate purity. Some other values will be given little weight because of the inadequate reliability of the physical measurements themselves. Frequently, a guide to the problem of selection of a "best" value may be established by

Adapted from report presented at annual A.P.I. meeting, Chicago, November 8, 1954.

ascertaining what values the given investigators may have obtained on a reference compound for which quite accurate values are known.

The selection of the "best" value of a given property of a given compound is frequently done not for one individual compound alone but for a group of structurally related compounds together. By handling the compounds in groups the reliability of the selection of the individual values is strengthened through correlation of the numerical values with molecular structure.

Two important methods of correlation of values of properties with molecular structure are used by the project in its work. One of these involves correlation of the values of some property for the compounds constituting an homologous series, as the normal paraffin hydrocarbons, or the normal alkyl cyclopentanes, or the normal alkyl olefins (1-alkenes), or the normal alkyl benzenes, and the like.

In general, the end group Y, to which the normal alkyl radical is attached, may be any hydrocarbon group or nonhydrocarbon group of atoms. The general formula for such an homologous series of compounds may be written as:

$$Y-(CH_2)_n-H$$

where n may have integral values from 0 to any large number.

Effect of CH_2 groups . . . For an extensive property, such as volume, or heat of combustion, and the like, the change in the value of the given property on the addition of a CH_2 group may become constant or nearly so, changing in a smooth, regular manner with the number of carbon atoms. For an intensive property, such as refractive index or density, the value of the property changes with the number of carbon atoms in a regular manner and, for n equal to infinity, approaches a limiting value which is independent of the end group Y.

In any such homologous series the value of the given property changes most markedly for the first several numbers of the series, as for n from 0 to about 5. It is clear that in order to evaluate a given property for all the members of such an homologous series —say from $n = 0$ to $n = 40$—it will not be necessary to have data on all of the compounds of the series.

In actual practice the data on the series of normal paraffins are the most extensive and are used as a pilot to test the method for the given property. Then for the same property for another homologous series, values for all the members can be evaluated when data on only one-fourth or less of them are available. For example, for the series of normal alkyl cyclohexanes, values for the members having $n = 0, 1, 2, 3, 4, 10$, and 20, could well serve to permit calculation of values for all the members of the series.

The great power and advantage of this method of operation is illustrated by the following facts: at the end of 1952 the total number of hydrocarbons of higher molecular weight in the normal alkyl series of the different classes, for which selected values of properties were given in the tables of the project, was 210.

Of those 210 compounds, only 100 had ever been measured by man, the values for the other 110 compounds having been calculated in the manner described hereinbefore. Although this method of correlation has been used by the project since 1947, the detailed description of the method is only now being prepared for publication.

Isomer correlation . . . The second method of correlation used by the project involves groups of isomers, wherein the difference in the value of the given property between the normal compound and any one of its isomers is correlated with differences in their molecular structure.

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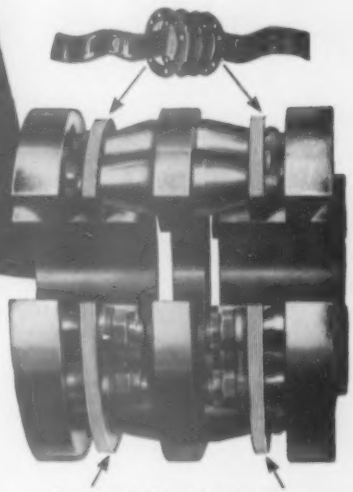

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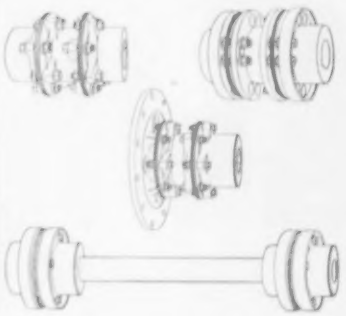

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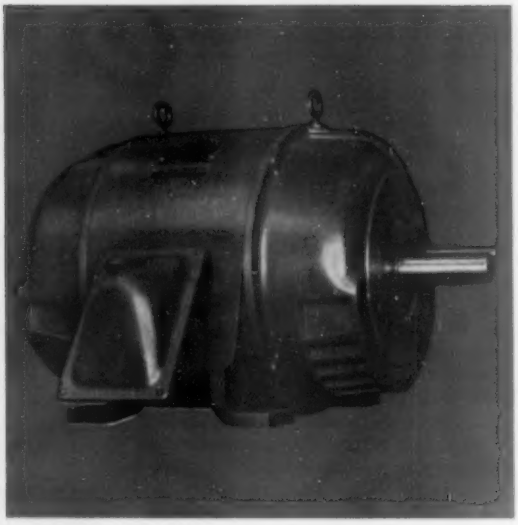

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A.P.I.—Research Project

The value of a given property of a given isomer is taken as a first step, to consist of a given constant contribution for each CH_3 group, a different given constant contribution for each CH_2 group, a different given constant contribution for each CH group, and a different given constant contribution for each C group. The next step is to add a contribution for the interaction between adjacent groups, as between one CH_3 group and one CH_2 group.

The values of the contributions to the given properties arising from each group as an entity and the contributions assigned to the interactions between adjacent groups are evaluated by a correlation of the existing data with molecular structure for those groups of isomers for which the data are quite reliable, as for example the 5 isomeric hexanes, the 9 isomeric heptanes, and the 18 isomeric octanes.

Once the values of the several constants have been determined in this way, the value of a given property for one of the higher paraffins — say a nonane—may be obtained directly from the summation of the contributions from component parts of the molecule, together with the contributions from interactions between adjacent component groups.

It should be pointed out that, although there are apparently 14 constants to be evaluated—4 from the component groups and 10 from the interactions of adjacent component groups—actually the number of constants is reduced to 7 because of certain relations involving the number of groups and their interactions.

Powerful tool . . . The foregoing procedure has been found to be a very powerful one in evaluating the properties of higher hydrocarbons for which no data exist. However, in the performance of such calculations, two possible improvements of marked value have been noted. First, it appears desirable to take into account certain variations in the property of the same group structure arising from increase in the number of carbons of the whole molecule in going up to molecules of high molecular weight.

Second, for molecules of more branched structure it seems desirable to take into account interactions between nonadjacent component parts of the molecule. New developments along these lines are in process and will appear in a doctoral thesis by Greenshields, emanating from the work of the project.

Other correlations which are regularly carried out by the project include correlations with temperature of the values of a given property of a compound to obtain values for other temperatures and correlations with pressure to obtain values for other pressures. The properties for which correlations with temperature have been made include density, viscosity, vapor pressure, and a number of thermodynamic properties. The properties for which correlations with pressure are being made include certain P.V.T. and related thermodynamic properties.

As has been repeatedly emphasized, the tables of the project contain many data which have been created by calculation and correlation, and which represent information on compounds never measured or prepared by man. Yet, within the same indicated limits of significant figures, such values have a reliability commensurate with other values whose selection was based entirely on experimental data.

Compiling and Printing the Data

Once the selection of "best" values for given properties of a given group of compounds has been completed in the manner described hereinbefore, the responsible investigator carefully prepares a handwritten master table of

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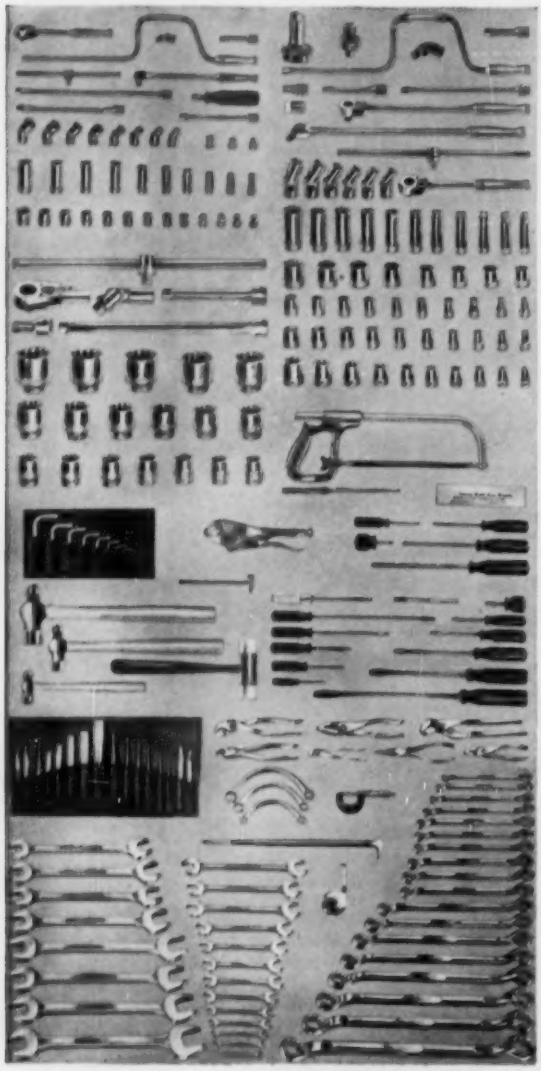

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A.P.I.—Research Project

the given properties and compounds. Then follows the preparation of a typed master table and the proofreading of it against the handwritten master table. This is the end of the proofreading, as the printing is performed directly from plates made from the master typed table.

At the present time 1,500 copies of each table of data are printed. The printed sheets are loose leaf, 8 by 10½ in. in size, one side only.

Revision of the Tables

Once the project has issued a given table of data, it assumes responsibility for maintaining the table up to date by revision at appropriate intervals. The time between revisions of a given table may be long or short. If no new data become available, no revision is made. If there appear many new data significantly different from those available before, a revision is scheduled promptly. Some revisions have been made in periods as short as 6 months. Others have waited 6 years.

Data on Punch Cards

For the convenience of those laboratories which have automatic machines for handling and calculating with punch cards, all of the data of the project on physical and thermodynamic properties, extant as of June 30, 1952, were placed on I.B.M. punch cards, a complete set comprising 35,905 cards. Plans are under way to arrange for supplements to include the newer data of the project. Details of the arrangement of the data on these cards and their use are given in a publication of the project.

P.V.T. and Related Properties

Although no data sheets pertaining to P.V.T. and related properties have yet been issued, some are expected to be completed within the next year. Plans and work on these properties have been under way since July 1, 1952. The general plan is to arrange these data in tabular form for different pressures at given levels of temperature in such a way as to be combined, as appropriate, directly with the values of the thermodynamic properties for the standard thermodynamic reference state of unit fugacity.

The compounds now scheduled for this program are methane, ethane, propane, normal butane, isobutane, and normal pentane. The calculations are quite involved and lengthy, and will be done with the aid of ultrarapid electronic calculators. It is estimated that all the values for methane alone will require about 100 sheets for presentation in the manner described hereinbefore.

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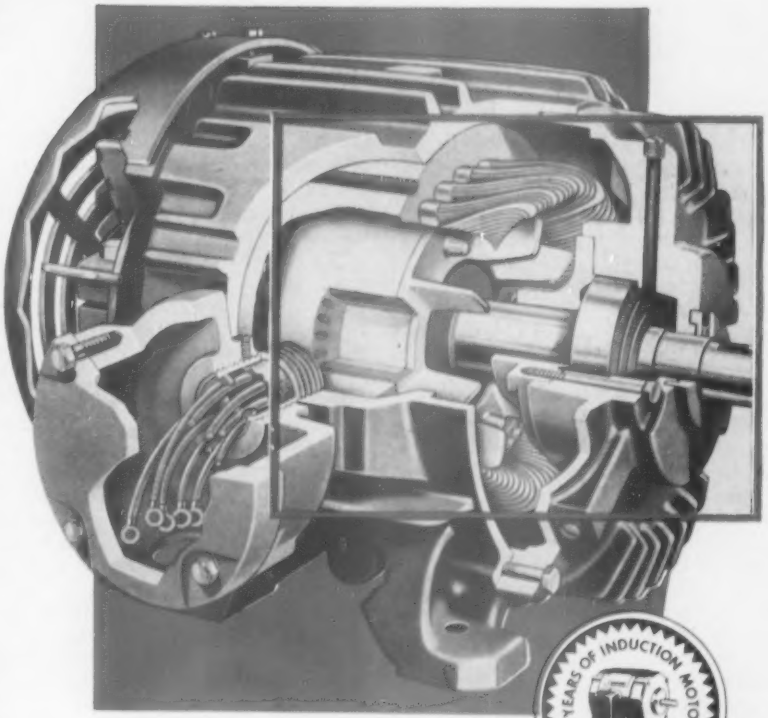

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PROGRESS REPORT: A.P.I. Research Project 45

Low-Molecular-Weight Hydrocarbons in Petroleum

RESEARCH PROJECT 45 completed its sixteenth year on July 1, 1954. It has produced, purified, and examined 296 pure hydrocarbons in total volume of 422 gal, and at an average cost of approximately $1,400 per gal. The engine data tables contain more than 7,000 items.

The present emphasis is on unsaturates. The hexene and heptene families are nearing completion, including geometric isomeric forms. The use of high-efficiency stills has made possible the use of the dehydration of carbinols as a method of synthesis, even though the boiling points of the several isomers lie close together. Unique methods of synthesis have been devised for those hydrocarbons not available by the standard methods.

Oxidation studies and the engine data seem to indicate that the octane numbers and/or critical compression ratios of noncyclic hydrocarbons vary inversely as the number of saturated CH_2 groups they contain. When the engine data are tabulated on this basis, within any group of hydrocarbons having the same number of methylene (CH_2) groups, the one having the more highly centralized structure has the higher octane rating.

Hydrocarbons containing the neopentyl structure do not conform to the foregoing system of classification, but seem to form a separate system of their own.

Knock tables . . . The number of engine-evaluation data tabulated in the project's knock-test data tables has increased from 6,500 to more than 7,000 items during the past 2 years. All the members of the paraffin series through C_8 have been engine tested as well as 27 paraffins with a larger number of carbon atoms. Of the olefin series, data have been obtained on all 13 of the structurally isomeric hexenes and on all but one of the geometric forms.

Of the 36 isomeric heptenes (including geometric forms) the data on 22 are in hand. Material for eight additional heptenes (one duplicate) are also available. The remaining seven involve new structural isomers and a total of six geometric forms. The completion of this family is being given high priority.

Adapted from report presented at national meeting, A.P.I., Chicago, November 8, 1954.

Although cis and trans forms usually do not differ widely in their knocking characteristics, it is quite essential to know accurately the physical properties of all isomers to be able to differentiate and identify the components of a mixture.

Cycloparaffins . . . The cycloparaffin series is wonderfully complex. Fifty-nine members of the series have been engine tested, including three with unsaturation in the side chain. Data are available on some members of each family of cycloparaffins, from cyclopropane to cyclooctane. The base line for the cycloparaffins has been completely laid down except for cyclobutane which is on the synthesis program.

The cyclopentanes and cyclohexanes form the keystone of the napthenes. They occur widely distributed in petroleum, and find their way into commercial gasolines. Thirteen monoalkyl (three unsaturated) and seven dimethyl and trimethyl derivatives compose the cyclopentane group. The structural pattern of the polymethyl cyclopentanes becomes very complex because of the multiplicity of the geometric forms.

Not only do these geometric isomers occur in commercial gasolines, but they differ more widely in their knocking characteristics than the geometric forms in the olefin series. The exploratory work on this group has been very largely completed.

Twenty-eight cyclohexanes have been produced, two having unsaturation in the side chain. The group includes 13 monoalkyl and 15 dialkyl and trialkyl derivatives. The latter groups contain four cis-trans pairs. The exploratory work in this field is made exceptionally difficult by the multiplicity of geometric forms. It can be said that definite progress is being made, and there is hope that all of the polymethyl derivatives ultimately will be brought into hand.

Aromatics . . . The engine data tables contain data on 39 aromatic hydrocarbons. The group contains all members of the aromatic series through C_9 and approximately one-half of those with C_{10}. Five of the aromatics have side-chain unsaturation. An examination of the engine data tables will show that nearly all aromatic hydrocarbons thus far examined have A.S.T.M. D 908 (research method) octane numbers above 100.

During the past 2 years emphasis has been placed on the study of monoolefins and cyclic unsaturates. This paper includes a synopsis of the methods employed in the synthesis of these olefins and a review of the relationships which have been discovered between their molecular structure and their knocking characteristics. In addition, a reaction - mechanism scheme derived from these correlations between structure and knocking tendency is proposed for the oxidation of noncyclic hydrocarbons.

Olefin synthesis . . . The most convenient method for the synthesis of olefins is by the dehydration of carbinols. The carbinols, in turn, are best produced by the Grignard reaction. The dehydration is accomplished by either thermal or acid catalysis, and is most readily understood on the basis of the carbonium-ion theory.

In the usual case a complex mixture of olefins is obtained, which can be separated only by the use of high-efficiency columns.

Hydrocarbon Structure and Engine Behavior

The 7,000 data in the project's engine data tables offer an opportunity for generalizations between knocking characteristics and the hydrocarbon structure. The problem is complex, and broad generalizations cannot be made easily.

The literature is replete with statements of limited application: "the more highly branched the hydrocarbon structure the higher the octane number;" "the longer the principal chain the lower the octane number;" and "the introduction of a double bond improves the knocking characteristics."

Each of these statements expresses a trend recognizable in the data, but they do not have broad general application, nor do they tell us why it is so.

A memorandum contributed to the project is entitled "Knocking Characteristics of Olefinic Hydrocarbons," and begins with the following foreword: "The antiknock ratings of pure, aliphatic mono-olefins, which have been extensively determined by American Petroleum Institute Research Project 45, are of particular interest because of the pronounced effect of changes in

the molecular structure of these compounds on their knocking characteristics. Clear antiknock level, response to tetraethyllead, sensitivity to engine operating conditions, and also blending properties are radically affected by:

"1. The introduction of a double bond into a parafin,

"2. Shifting the double bond position to form isomeric olefins with different types of unsaturation,

"3. Branching or centralization of side chains of isomeric olefins having the same type of unsaturation, and

"4. Increasing the number of carbon atoms of olefins with the same type of unsaturation."

Methylene groups . . . Oxidation studies seem to suggest that the knocking characteristics of a hydrocarbon or hydrocarbon derivative are in some way related to the number of methyl-

TABLE I

Knocking Characteristics of Some Olefins

Hexenes	No. of $-CH_2-$ Groups	Octane Number Research	Motor
(a) Butyl-Ethylenes			
C=C-CCCC	(3)	76.4	63.4
C=C-C(C)CC	(1)	95.7	80.9
C=C-C(C)CC	(1)	96.0	81.2
C=C-C(C)C (C)	(0)	+1.7	93.3
(b) Butyl-1-propenes			
Heptenes			
C-C=C-CCCC	(3)	73.4	68.8
C-C=C-C(C)CC	(1)	94.6	80.9
C-C=C-C(C)CC	(1)	96.8	83.0
C-C=C-C(C)C (C)	(0)	+0.5	90.9 90.2
(c) Butyl-3-propenes			
Heptenes			
C=C-C-CCCC	(4)		
C=C-C(C)CC	(2)	75.5	64.0
C=C-C(C)CC	(2)	86.4	74.0
C C-C(C)C (C)	(1)	+0.4	85.4
(d) Butyl-2-propenes			
C=C(C)-CCCC	(3)	90.7	78.8
C=C(C)-C(C)CC	(1)	99.2	84.6
C=C(C)-C(C)CC	(1)	99.3	84.2
C=C(C)-C(C)C (C)	(0)	+0.5	90.5

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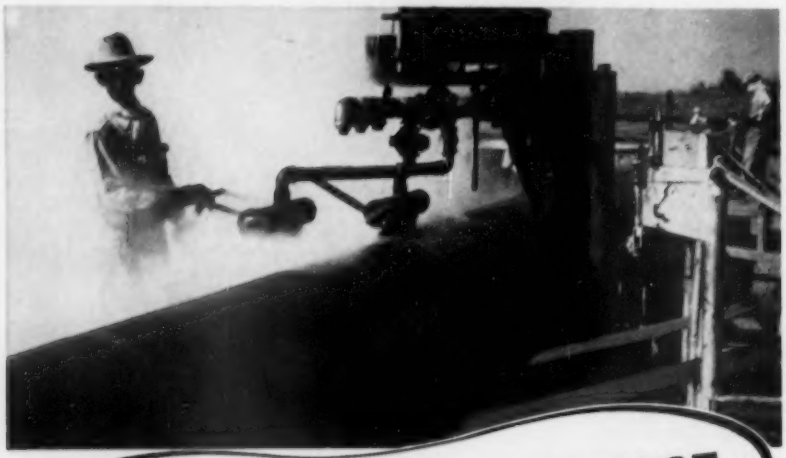
ene (CH_2) groups the compound contains. To follow up this idea the butyl derivatives of ethylene and propylene have been tabulated in Table 1.

It will be noted that each group—(a), (b), (c), and (d)—forms an example of the third stipulation, viz.: "... centralization of the side chains of isomeric olefins having the same type of unsaturation." One observes that as the n-butyl group is telescoped to form a tertiary butyl group, the number of methylene groups is decreased, and the octane number is increased.

In those cases in which the butyl group is joined directly to unsaturated carbon—as in (a), (b), and (d)—the octane numbers of the isobutyl and secondary butyl derivatives lie very close together, whereas in (c), in which these groups are one carbon atom removed from the double bond, the ratings differ by as much as 10 to 11 octane numbers.

The heptenes of type I afford an excellent illustration of the first and third conditions. As the double bond is introduced into each heptane, the knocking characteristics are increased over the corresponding paraffin.



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A.P.I.—Research Project

Isomerization . . . When a paraffin or an olefin is isomerized, the carbon atom removed to form the branch decreases the number of methylene groups by one. When the branch is reattached, somewhere along the chain another CH_2 group is destroyed.

Or, when a double bond is introduced into the alpha position of a normal paraffin one methylene group is lost. If the double bond is moved toward the middle of the chain, still another CH_2 group is eliminated.

In a type I olefin if an n-alkyl grouping is isomerized until the point of branching becomes next adjacent to the double bond, the CH_2 groups are eliminated one by one.

The longer the normal paraffin or olefin chain, the more methylene groups it contains.

Many paraffins do not contain the methylene group. Methane, ethane, isobutane, neopentane, diisopropyl, triptane, hexamethylethane, and 2,3,4-trimethylpentane are typical examples. Such paraffins have relatively high knocking characteristics. Many olefins also are free of CH_2 groups, except those which occur at the end of a double bond.

Ethylene, propylene, isobutylene, 2-butene, isopropylethylene, trimethylethylene and tetramethylethylene, and triptene may be cited as examples. Such olefins also have high knocking characteristics, but in some cases their values are lower than those of the corresponding paraffin. This fact may be attributed to the activating effect of the double bond—the so-called allyl effect.

Aromatics . . . All benzene derivatives thus far examined have research octane numbers above 100. The hydrogen atoms are not easily stripped from the benzene ring. The phenyl group is known to exert an activating effect upon the hydrogen atoms attached to the carbon atom in the alpha position of any side chain. Insofar as data are available, the knocking characteristics of the monobutyl derivatives of benzene, cyclopentane, and cyclohexane stand in the inverse order of the number of CH_2 groups in the side chain.

In the paraffin series the decrease in the number of CH_2 groups runs parallel to an increase in the number of methyl groups, and the increased knocking characteristics might be attributed to this increase in methyl groups. But, if a double bond is introduced in such a manner as to eliminate a methyl group, the knocking characteristics continue to rise even though two hydrogen atoms have simultaneously come under the activating effect of the double bond.

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Y91	4	2⅞	3½	91	28.5 @ 2400 RPM
Y112	4	3 1/16	3½	112	32 @ 2400 RPM
F124	4	3	4½	124	36 @ 2400 RPM
F140	4	3 1/16	4½	140	42 @ 2400 RPM
F162	4	3 1/16	4½	162	49 @ 2400 RPM
F186	6	3	4½	186	60.5 @ 2400 RPM
*E201	4	3⅝	4½	201	59 @ 2000 RPM
F209	6	3 1/16	4½	209	68 @ 2400 RPM
F226	6	3 1/16	4½	226	73 @ 2400 RPM
F244	6	3 1/16	4½	244	79 @ 2400 RPM
M271	6	3⅜	4½	271	86.2 @ 2400 RPM
M290	6	3¼	4½	290	92.2 @ 2400 RPM
M330	6	4	4½	330	104.4 @ 2400 RPM
M363	6	4	4 13/16	363	109 @ 2000 RPM
B371	6	4⅛	4½	371	110 @ 2400 RPM
B427	6	4 5/16	4⅞	427	127 @ 2400 RPM
G134	4	3½	4½	134	32.2 @ 2000 RPM
G157	4	3½	4½	157	37.7 @ 2000 RPM
H227	4	3¾	5½	227	52 @ 1800 RPM
H243	4	3¾	5½	243	56 @ 1800 RPM
*H260	4	3⅞	5½	260	60 @ 1800 RPM
T371	6	4⅛	4½	371	119 @ 2400 RPM
*J382	4	4½	6	382	74.2 @ 1400 RPM
T427	6	4 5/16	4⅞	427	140 @ 2400 RPM
U501	6	4½	5¼	501	160 @ 2400 RPM
R513	6	4½	5⅛	513	164.3 @ 2400 RPM
R572	6	4¼	5⅛	572	182.4 @ 2400 RPM
R602	6	4⅜	5⅛	602	191.7 @ 2400 RPM
S749	6	5⅛	5½	749	217 @ 2200 RPM
S820	6	5⅝	5½	820	237 @ 2200 RPM

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GD157	4	3½	4½	157	39 @ 2000 RPM
*ED201	4	3⅝	4½	201	45.8 @ 2000 RPM
HD243	4	3¾	5½	243	54.7 @ 2000 RPM
*HD260	4	3⅞	5½	260	59.3 @ 2000 RPM
*JD382	4	4½	6	382	72.5 @ 1600 RPM
TD427	6	4 5/16	4⅞	427	106.5 @ 2000 RPM
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PROGRESS REPORT: A.P.I. Research Project 48

SULFUR COMPOUNDS IN PETROLEUM

A.P.I. Research Project 48 has made excellent progress during the past 2 years in achieving its objectives of obtaining data on sulfur compounds found in petroleum, and in identifying individual and type sulfur compounds in a typical (Wasson) high-sulfur crude oil.

The fundamental-research program has developed methods for the synthesis of thiols by the addition of thiolacetic acid to olefins, followed by hydrolysis. By the use of this approach with halo olefins, an excellent synthetic route for the preparation of cyclic sulfides has been developed. Studies on the synthesis and chemistry of benzothiophenes and on the chemistry of the oxidation of sulfides have yielded important data regarding these types of sulfur compounds. Fifteen samples were synthesized and contributed to the small-scale program.

Since 1952 ten high-purity (99.9+ per cent) sulfur compounds have been prepared in large volume, and 35 additional compounds have been obtained in smaller volume. The large-volume compounds have been made available for distribution through the A.P.I. samples and data office.

These additions make a total of 30 very pure compounds prepared by the project. Complete physical properties and spectra are available on these. The total of small samples on which spectral data have been obtained is now 91 and, for these, 212 spectra have been determined, which are available through A.P.I. Project 44.

Thermodynamics . . . Significant amounts of new data are resulting from systematic thermodynamic studies on sulfur compounds. Entropy and heat-of-combustion data—and, hence, free energies—are now available for the isomeric C_3H_8S and $C_4H_{10}S$ alkane sulfides and thiols as well as for a number of other compounds. Measurements and/or calculation of thermodynamic properties are complete or in progress on 27 sulfur compounds.

Since 1952, 27 sulfur compounds have been identified in Wasson crude oil, bringing the total to 43. The boiling range of distillates studied has been increased to 220° C. Adsorption on alumina has been applied successfully to concentrating the sulfur compounds in several boiling-range distillates; thiols have been separated quantitatively by the use of sodium aminoethoxide in ethylene-diamine solution; chain and cyclic sulfides have been separated by zinc chloride and by adsorption or thermal diffusion; and studies of topped deasphaltened Wasson crude oil show that benzothiophenes with one, two, and three or more aromatic rings are the predominant sulfur compounds present.

The possibilities of thermal diffusion and adsorption have been investigated using binary mixtures of pure sulfur compounds or hydrocarbons. The reactions of elemental sulfur with hydrocarbons, and analytical methods for elemental sulfur, disulfides, and trisulfides have been further studied.

Adapted from report presented at annual meeting, A.P.I., Chicago, November 8, 1954.

Compound Synthesis

The investigation by Project 48b of the best methods for synthesis of the sulfur compounds present in petroleum in a high state of purity has continued during the past 2 years. Particular attention has been given to the preparation of thiols by the addition of thiolacetic acids to olefins, followed by hydrolysis. This reaction has proved valuable not only for the preparation of thiols, but also has provided a new approach to the synthesis of cyclic sulfides. The reaction of phenyllithium with benzothiophene followed by alkylation has been found to yield 2-alkylbenzothiophenes in a high state of purity.

Investigations relative to the chemical properties of sulfur compounds carried out during this period include: (1) preparation and measurement of acidity of thiophenols; (2) study of the preparation of sulfoxides by oxidation of sulfides, and of the rates of some of these reactions; and, (3) further investigations of benzothiophene chemistry.

Fifteen samples have been synthesized and furnished to the small-sample program. Almost every one of these has resulted in an identification of a sulfur compound in Wasson crude oil. This illustrates the importance of the basic synthesis program.

Samples available . . . Through July 1, 1954, 30 high-purity (99.9+ mole per cent) sulfur compounds have been prepared in large volume (1 to 3 l.). After they have been bottled, they represent a potential sales value to the Institute of more than $200,000. These compounds have varied uses. They furnish other phases of the project material for measurement of physical, spectroscopic, and thermodynamic data; and for identification, by comparison, of compounds isolated from petroleum.

They are sold as calibration standards and, on occasion, are loaned or donated for specialized scientific studies. Preparation of the compounds involves chemical synthesis operations, painstaking purification by distillation, crystallization and other techniques, purity measurements, and packaging operations. The rate of production has been maintained exactly as contemplated in the original program.

Spectra data . . . Physical properties and spectra are the best means of compound identification, and the data determined by Project 48 are so accurate and on such highly purified compounds that they should be standards for years to come. Complete physical properties (freezing point, boiling point, density at three temperatures, refractive indexes for seven wave lengths and three temperatures, cryoscopic constant, surface tension at three temperatures, and viscosity at three temperatures) have been determined on 24 highly purified sulfur compounds through July 1, 1954.

These measurements are made available both through publication and through their use by A.P.I. Research Project 44 in the selection of the best values of physical properties of sulfur compounds. Because of their high accuracy they have been heavily weighted in these selections. Correlative work employing these measurements is now in progress. Similarly, infrared, ultraviolet, and mass spectra are determined by Project 48a. These spectra, which have been completed for the first 20 compounds, are made available through the spectral catalog maintained by Project 44.

More than 200 spectra have been obtained to expedite the analytical and identification work, and to meet the increasing needs of the petroleum industry for data on sulfur compounds. These spectra have resulted from a program, started in 1950, of procuring and measuring spectral properties on a large number of compounds which were available only in small volumes (50 to 200 ml.).

In the 4 years in which the program has been operative, 91 compounds have

been procured through synthesis by Project 48b at Northwestern University or by donation from outside sources. Through the cooperation of the petroleum industry, various spectra have been measured on 67 of these compounds, resulting in 212 spectra which are now included in the spectral catalogs of A.P.I. Research Project 44.

Thermodynamic data . . . The determination of accurate thermodynamic data for sulfur compounds continues. New property values have been obtained as follows: entropy of the liquid at 25° C. (9 compounds); heats of combustion and formation (14 compounds); heat capacity of vapor and heat of vaporization (7 compounds); vapor pressures in the range of from 150 to 2,000 mm. of mercury (4 compounds); and thermodynamic functions from calorimetric, spectroscopic, and molecular-structure data (6 compounds).

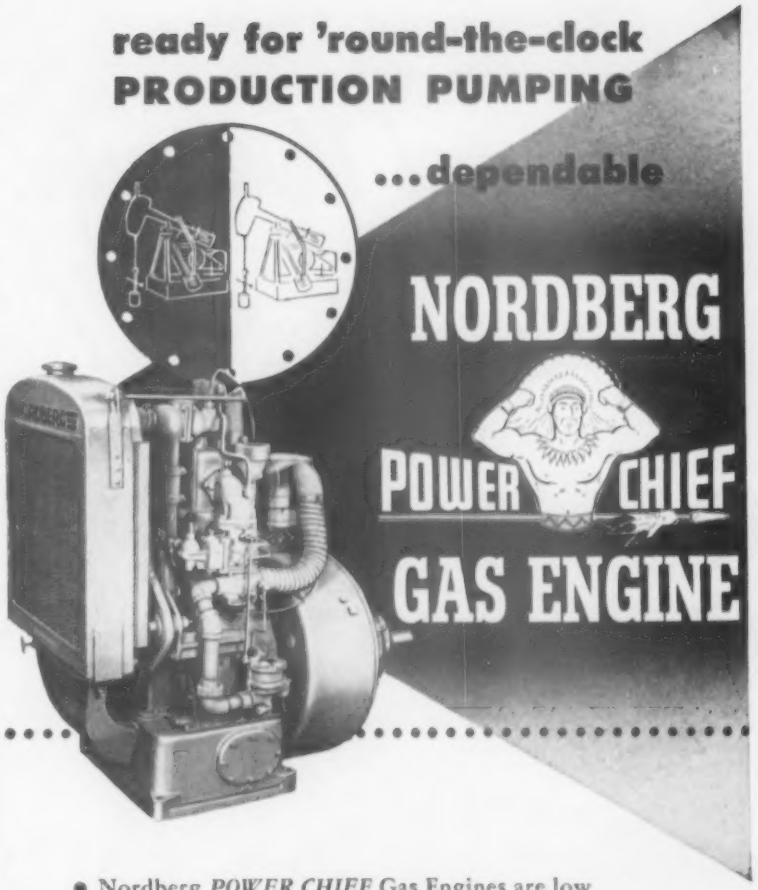
Worthy of note is the completion of measurements on the three isomeric C_3H_8S alkane thiols and sulfides, seven $C_4H_{10}S$ alkane thiols and sulfides, and 2- and 3-methylthiophene. The recently developed rotating bomb for determination of heats of formation and combustion is in use on a routine basis, and its productivity is significant. It will now be possible to obtain sufficient combustion data to develop correlations which will permit prediction of properties of higher members of homologous series.

The need by Project 48a for good thermodynamic data for elemental sulfur to use in conjunction with data on sulfur compounds has led to the initiation, at the National Bureau of Standards, of experimental work (supported in part by A.P.I. funds) for accurate determination of the heat capacity of liquid sulfur.

Identification studies . . . The separation and identification studies have resulted in the identification of 43 sulfur compounds in Wasson crude oil (Table 1), all except one boiling below 150° C. From these data it appears that: secondary mercaptans, the most prevalent type, become of negligible importance when the average carbon content of the molecule is 12 or 13; primary mercaptans disappear at 5 to 6 carbon atoms; and the content of tertiary mercaptans is negligible.

Somewhat analogous conclusions apply to the open-chain sulfides, in that they also appear to become of negligible importance in the higher-molecular-weight fractions of crude oil.

The sulfides boiling between 110° and 150° C. are predominantly cyclic.



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A.P.I.—Research Project

This trend continues into the 150° to 220° C. boiling range. Finally, by careful chromatography of a Wasson crude oil topped to 150° C., and deasphalted with pentane, it has been possible to show by mass and ultraviolet spectra (courtesy Humble Oil & Refining Co.) that 15 per cent of the oil consists of sulfur compounds, and

TABLE 1

Sulfur Compounds Identified in Wasson, Texas, Crude Oil and Estimated Per Cent by Weight Present Whenever Known

Name	Boiling point (°C.)	Weight per cent in Wasson, Tex., crude oil*
Methanethiol	5.96	0.00240
Ethanethiol	35.0	.00530
2-Thiapropane	37.31	.00088
2-Propanethiol	52.56	.00199
2-Methyl-2-propanethiol	64.22	.00055
2-Thiabutane	66.65	.00222
1-Propanethiol	67.5	.00041
3-Methyl-2-thiabutane	84.81	.00064
2-Butanethiol	85.15	.00386
2-Methyl-1-propanethiol	88.72	.00003
3-Thiapentane	92.10	.00075
2-Thiapentane	95.52	.00030
1-Butanethiol	98.4	Trace
2-Methyl-2-butanethiol	99 0	.00064
3, 3-Dimethyl-2-thiabutane	99.0	
2-Methyl-3-thiapentane	107.4	
3-Methyl-2-butanethiol	109.8	
2-Pentanethiol	112.9	.0014
3-Pentanethiol	113.9	.00057
4-Methyl-2-Pentanethiol		
3-Methyl-3-pentanethiol		
3-Thiahexane	118.50	.00012
2, 4-Dimethyl-3-thiapentane	120.02	.00053
2, 2-Dimethyl-3-thiapentane	120.41	.000058
Thiacyclopentane	121.12	.000077
2-Thiahexane	123.2	.000077
2-Methyl-3-thiahexane	132.05	.000078
Cyclopentanethiol	132.2	
2-Methylthiacyclopentane	133.23	.0023
4-Methyl-3-thiahexane	133.65	.00050
3-Methylthiacyclopentane	138.67	.00046
2-Hexanethiol	138.9	.0028
Thiacyclohexane	141.75	.00032
trans-2, 5-Dimethylthiacyclopentane	142.0	.0025
cis-2, 5-Dimethylthiacyclopentane	142.28	.0024
3-Thiaheptane	144.24	.000078
2-Methylthiacyclohexane	153.04	.0029
3-Methylthiacyclohexane	158.04	.000024
4-Methylthiacyclohexane	158.64	.000048
Cyclohexanethiol	158.8	.0012
Tentatively identified		
3-Hexanethiol		
cis-2-Methylcyclopentanethiol		
2-Octanethiol		

*These are minimum values. For the thiols and sulfides boiling below 100° C. and for thiols boiling above 100° C. the values should be 90-95 per cent correct. The values reported for cyclic and chain sulfides boiling above 111° C. may be low by 50 per cent because of processing losses.

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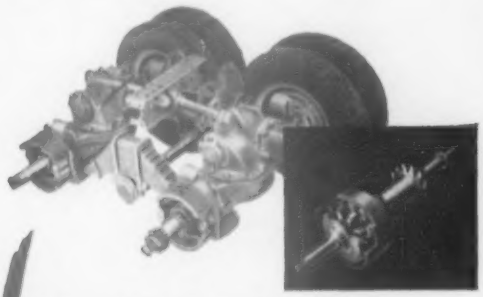

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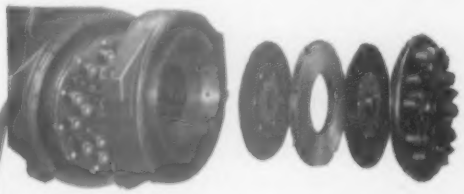

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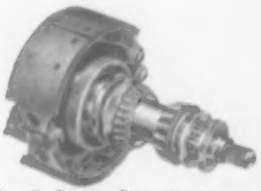

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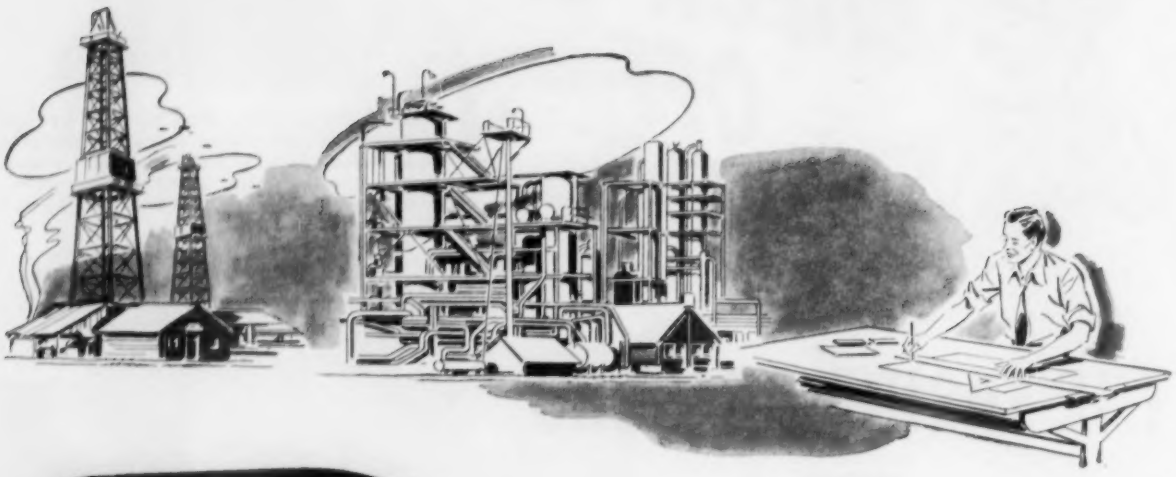

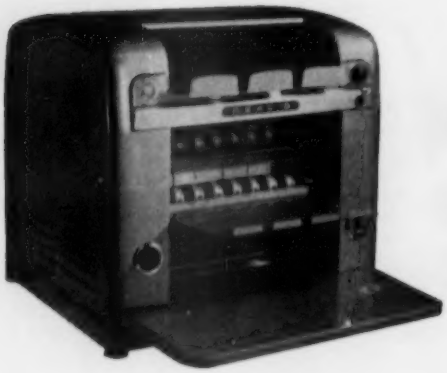

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that 80 per cent of the sulfur compounds contain a thiophene ring which is either alkylated or condensed with one or two aromatic rings.

These same samples were studied by mass spectra only by Shell Oil Co., Houston; and, although the data are not in complete agreement, they do confirm the fact that 15 to 20 per cent of Wasson crude oil boiling above gasoline consists of sulfur compounds, and that thiophenes condensed with aromatic rings are the predominant constituents of these sulfur compounds.

New and Improved Separative Processes

Adsorption . . . The concentration of sulfur compounds by adsorption on alumina has continued to be the principal separative method employed. Extension of the techniques has been made by experimentation with a whole crude oil, and with the crude oil modified by topping, deasphaltening, or both.

Liquid thermal diffusion . . . The process of liquid thermal diffusion is being investigated as a possible procedure to augment other concentration and separation processes. Project 48 is using in this study principally a 6-ft. stainless-steel column with a mean annulus diameter of 0.645 in. and an annulus ("slit") width of 0.012 in.

In comparing thermal diffusion with adsorption, each process has advantages and disadvantages peculiar to itself. For example, adsorption usually requires less over-all time but more attention during the time involved, whereas thermal diffusion requires more over-all time but far less attention during the processing. In addition, some blends are not separable by one or the other of the processes, and in such failures the second process will more than likely accomplish the separation.

Liquid ammonia . . . Studies have been made in the separation of primary and secondary thiols from tertiary by means of the solubility of their mercaptides in liquid ammonia. The limited solubility of thiols in liquid ammonia makes necessary the use of a mutual solvent such as n-hexyl carbitol, dimethyl ether, and others.

This problem is still under investigation, but has been employed in a practical case in a separation scheme applied to a thiol extract from 150° to 220° C. boiling-range distillate from Wesson crude oil. It is not anticipated that chemical separations will be totally effective, but analytical data indicate a separation efficiency of about 90 per cent for this method.

Sulfonium compounds . . . The chemis-

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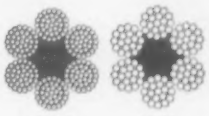

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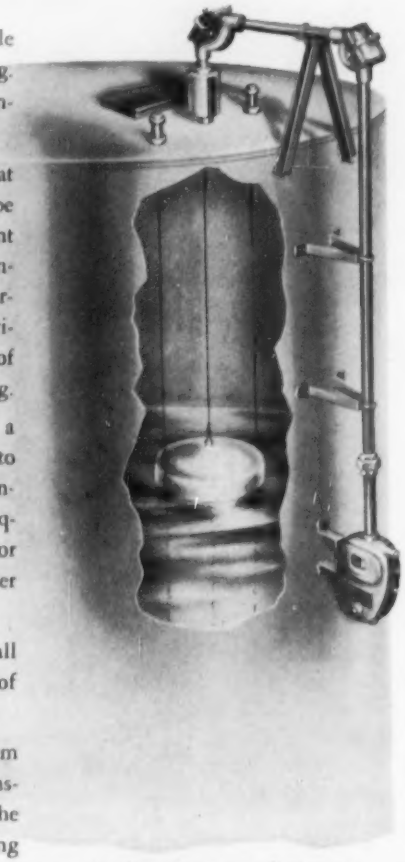

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A.P.I.—Research Project

try of sulfonium compounds is being investigated in the hope of finding reactions useful in the identification of sulfur compounds. Their use might be involved also in special instances to supplement the Raney nickel technique in locating the position of the sulfur atom in the molecule.

Raney nickel . . . Raney nickel has been successfully employed in the desulfurization of sulfur compounds for purposes of identification. Thus hexyl cyclohexyl sulfide can be converted practically quantitatively to cyclohexane and n-hexane. A commercial mixture of tertiary hexyl thiols was identified as a mixture of the three possible tertiary thiols, and their percentages were determined.

An attempted analysis of a fraction from a distillation of a thiol concentrate succeeded very well in that the thiols were converted to hydrocarbons. In this instance, because desulfurization does not reveal the position of the sulfur atom in the molecule, absolute identification of the thiols present in the fraction was not obtained.

Thiourea and urea . . . A system of multistage reactors was constructed to improve the degree of separation of cyclic and branched-chain form straight-chain sulfur compounds. The need for several modifications in design was indicated which, when completed, should permit a fair degree of separation.

Urea is very specific for straight-chain compounds having neither C-C or C-S branching within the chain. The adducts must be washed at low temperatures to prevent dissociation. Unfortunately this type of sulfur compound seems to be of little importance in petroleum.

New Analytical Developments

X-ray absorption . . . An improved procedure has been developed for the determination of total sulfur by X-ray absorption. The improvement lies in using monochromatic radiation provided by the fluorescence X-ray emitted by palladium when exposed to polychromatic X-radiation.

Polarographic analysis . . . Polarographic procedures for the determination of polysulfides and their possible thermal decomposition products have been studied. The following specific combinations in hydrocarbon solution are determinable within an error of ±5 per cent:

1. Dibenzyl trisulfide, benzyl disulfide, and elemental sulfur.
2. Di-n-butyl trisulfide, n-butyl disulfide, and elemental sulfur.
3. Ditertiary butyl trisulfide, diter-

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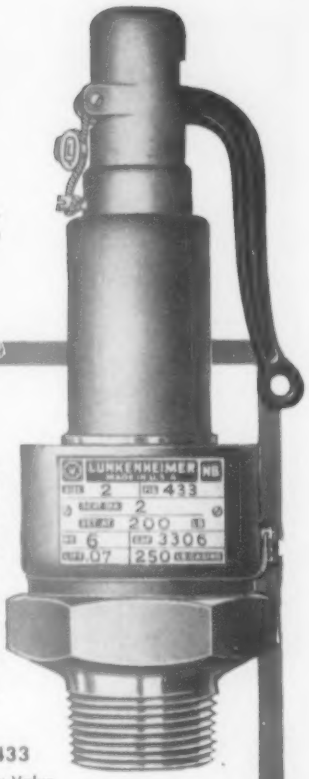

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Fig. 433
Pop Safety Valve

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Fig. 658
Relief Valve

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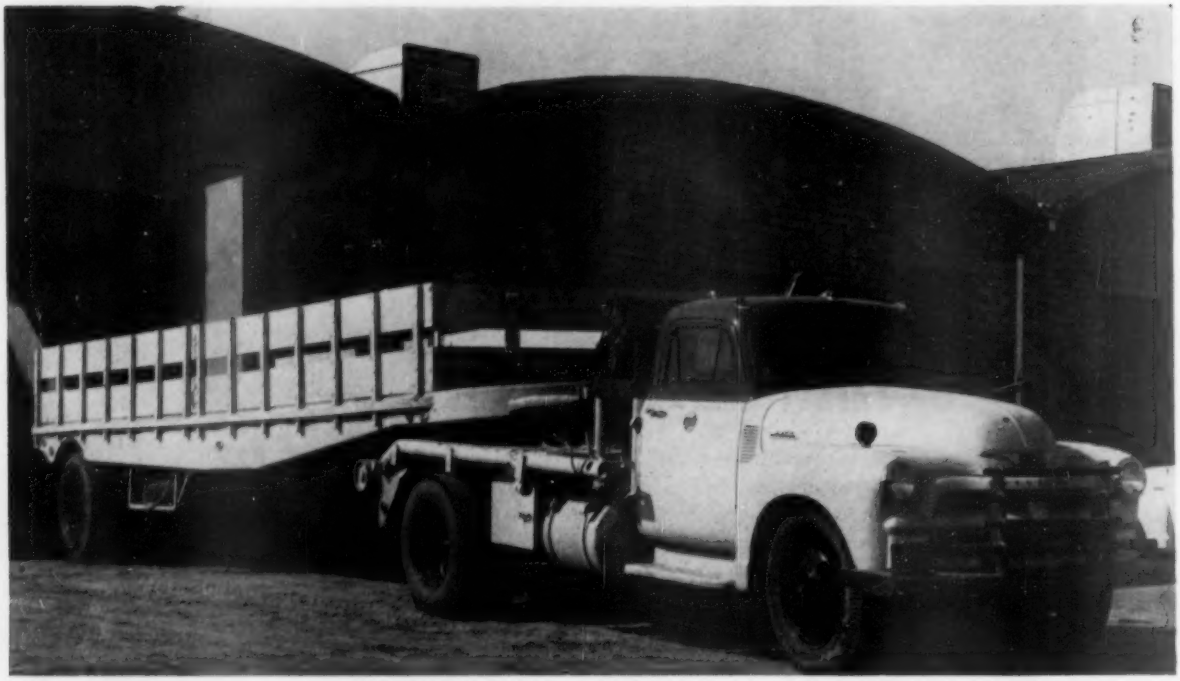

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tiary butyl disulfide, and elemental sulfur.

Reaction of Sulfur and Hydrocarbons

A limited investigation of the reaction of elemental sulfur with hydrocarbons was initiated. Initially four pure hydrocarbons (cetane, decalin, tetralin, cumene) and a commercial alkylate (branched-chain hydrocarbon) were selected for study. Later these were augmented by an olefin, thiocyclopentane, waxes, and a hydrogenated rosin.

The principal aim of this investigation was to determine at what temperature elemental sulfur would react with the selected material. Samples of the hydrocarbons, each containing 0.3 per cent by weight of elemental sulfur, were maintained at a desired temperature for a period of 3 weeks. Five-milliliter samples were withdrawn periodically for the polarographic determination of elemental sulfur, and evolved hydrogen sulfide was collected in cadmium chloride for measurement.

The following observations, relative to the reaction with the pure hydrocarbons, have been made:

1. At 75° C. there is no measurable reaction.
2. At 100° C. very slight reaction with tetralin.
3. At 125° C. tetralin reacts slowly but faster than at 100° C.
4. At 149° C. tetralin and cumene show definite reaction, with tetralin reacting the faster.

At 125° C. no measurable reaction occurred with the waxes or the hydrogenated rosin, but the thiocyclopentane gave evidence of yielding thiophene as a reaction product.

Looking ahead . . . It seems evident that the synthesis work—both the pioneering work of Project 48b and the large-scale work of Project 48a—must give greater emphasis to the synthesis and chemistry of cyclic sulfides and benzothiophenes.

As these activities increase and compounds become available for experimental studies, more attention will be given to development of analytical methods which will be applicable to improved type analyses for sulfur compounds. Concurrently, correlation between various physical properties will be developed, some of which may become as important as similar hydrocarbon correlations.

The next 2 years should see the thermodynamic data increase to such proportions and in such directions that generalization for the several families of sulfur compounds can be made, and reasonably accurate data predicted for

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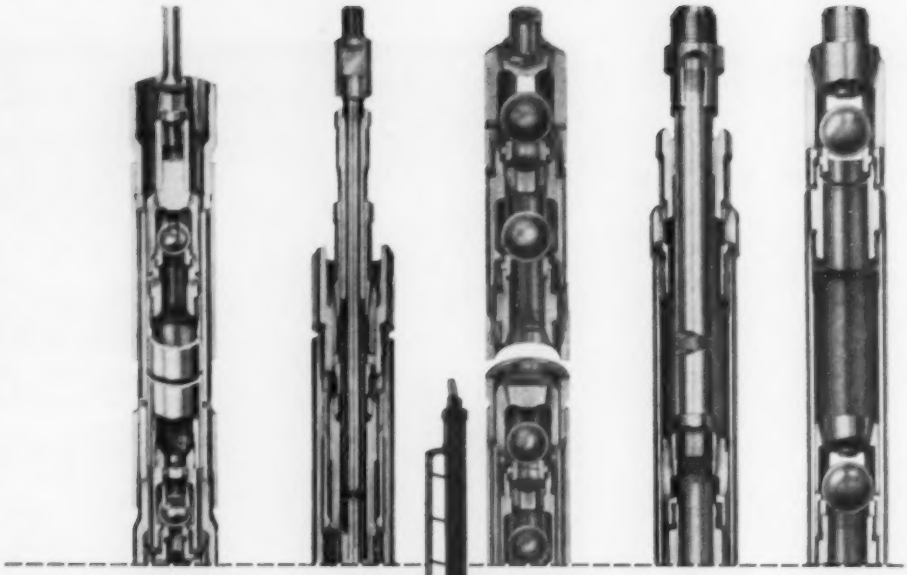

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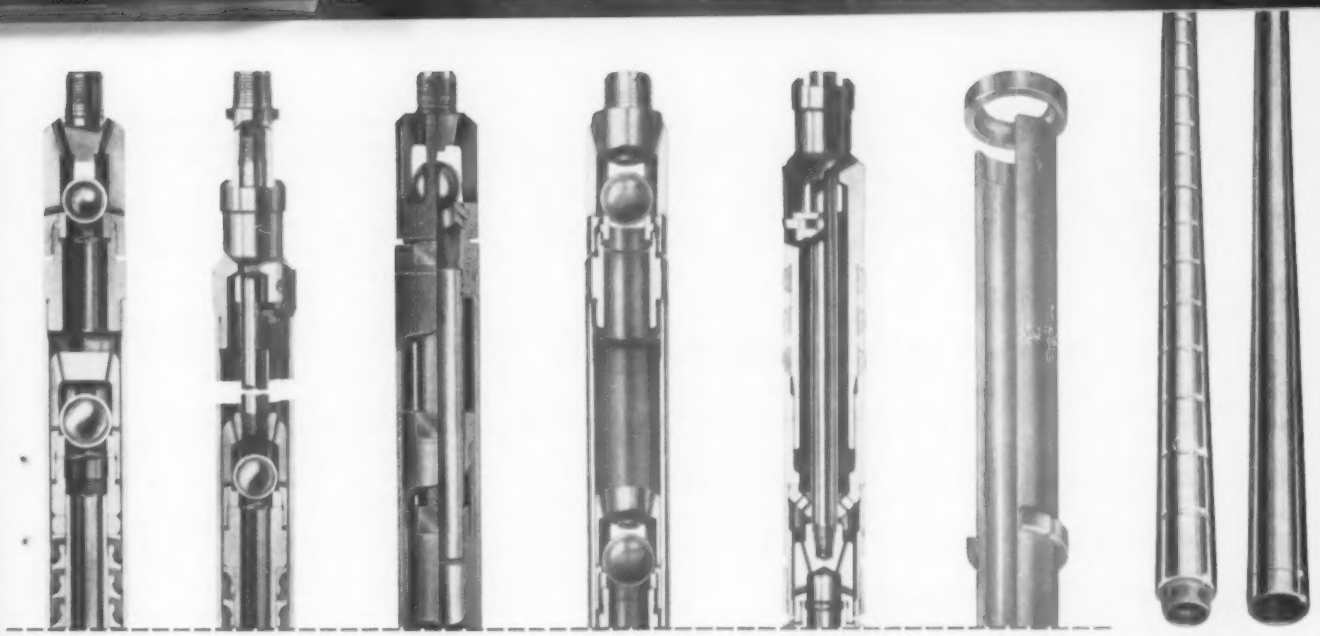

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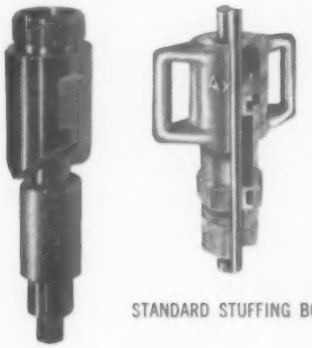

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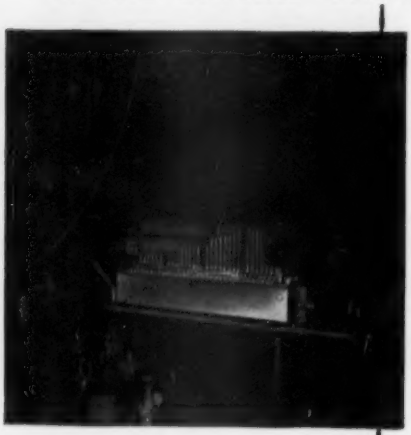

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A.P.I.—Research Project

more complex compounds. The data on elemental sulfur should be completed, and the reaction of sulfur with various hydrocarbons and between cyclic compounds can then be studied thermodynamically.

Analysis improvement . . . The methods of separation and analysis for the individual sulfur compounds in distillate boiling to 300° F. should be well established from studies on two or three crude oils, and occurrence trends for thiols and open-chain sulfides should be fairly definite.

Separation by type on higher-boiling distillates should be well advanced, using the sepearative techniques of adsorption and thermal diffusion. Also the separation of sulfur concentrates directly from the crude oil with only minor preliminary processing should be an established technique, ready for general application to any crude oil.

More will be known regarding the reaction of sulfur with hydrocarbons and heterocyclic compounds, and possibly some explanation will be found of what causes the release of hydrogen sulfide when a sulfur-bearing crude oil is heated.

Many more individual sulfur compounds will be identified, especially in the gasoline range, by means of new spectra which will become available. In addition, the use of the high-mass high-resolution mass spectrometer will greatly advance our knowledge of the type of sulfur compounds in the higher-boiling fractions.

One new and very real difficulty is already becoming apparent, viz., the presence of oxygen and nitrogen compounds in significant quantities in the higher-molecular-weight sulfur concentrates.

"I slipped."

PROGRESS REPORT: A.P.I. Research Project 50

Thermodynamic Properties of Hydrocarbons And Related Compounds

by K. S. Pitzer, G. C. Pimentel, and R. R. Brattain

IT is the purpose of A.P.I. Project 50 to further develop theoretical methods for the calculation of thermodynamic functions from molecular data and to establish the essential molecular data characteristic of hydrocarbon and closely related molecules.

The molecular-structure information involves not only the masses and equilibrium positions of the various atoms, but also the forces necessary to distort the various bond lengths and angles. These force constants usually are ascertained from molecular spectra but, because of the spectral inactivity of certain vibrations, it frequently is necessary to complete the picture by calculations — either from calorimetric data or from predictions regarding the potential function of the molecule.

Those vibrations or other distortions of the molecule which have relatively weak restoring forces are particularly important for thermodynamic purposes. This arises from the fact that thermal energy in these cases readily can excite the molecule to a higher quantum state associated with such a low-frequency motion. Consequently, particular attention is being given to spectra in the low-frequency region. Data from the grating spectrometer[1] play an important role in this program.

Internal rotation about a single bond is a typical motion with a low restoring force. Consequently, this type of motion is of particular thermodynamic importance. Also there are commonly several potential minima per revolution, and these minima may or may not be equivalent in energy. In order to understand better the forces associated with this type of motion, a number of simple substituted ethanes are being studied.

The general conclusions must await further work, but an important result arose from the studies on one single molecule, viz., 1,1,1-trichloroethane, or methyl chloroform. In this case sufficiently detailed spectral data were obtained to establish quite accurately the shape of the potential curve for this rotation with threefold symmetry. In particular, the energies of the first four quantum states were obtained.

This result is important because the shape of this type of potential curve has been assumed, and only the height has been determined from the single datum available in most cases. Fortunately, the more detailed information for methyl chloroform indicates that the simple cosine function usually assumed is a good approximation. This gives us increased confidence in the many cases in which heat capacities and other thermodynamic functions have been calculated over a wide range of temperature on the basis of an assumed cosine shape—but experimentally determined height—of potential barrier.

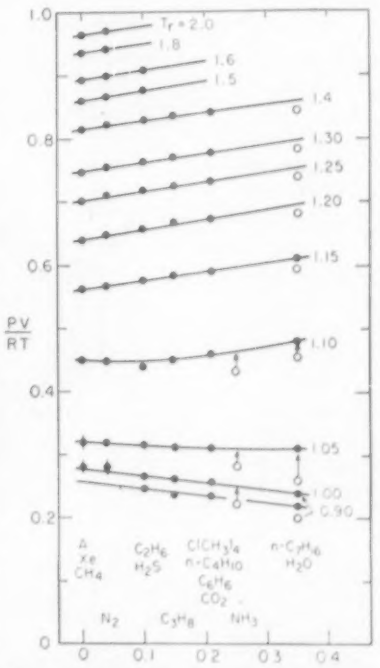


Fig. 1—Typical values of the compressibility factor showing conformity to correlation with the imperfection parameter.

K. S. Pitzer and G. C. Pimentel are associated with University of California, Berkeley. R. R. Brattain is associated with Shell Development Co., Emeryville, Calif. Paper presented at annual meeting, A.P.I., Chicago, November 8, 1954.

Naphthalene

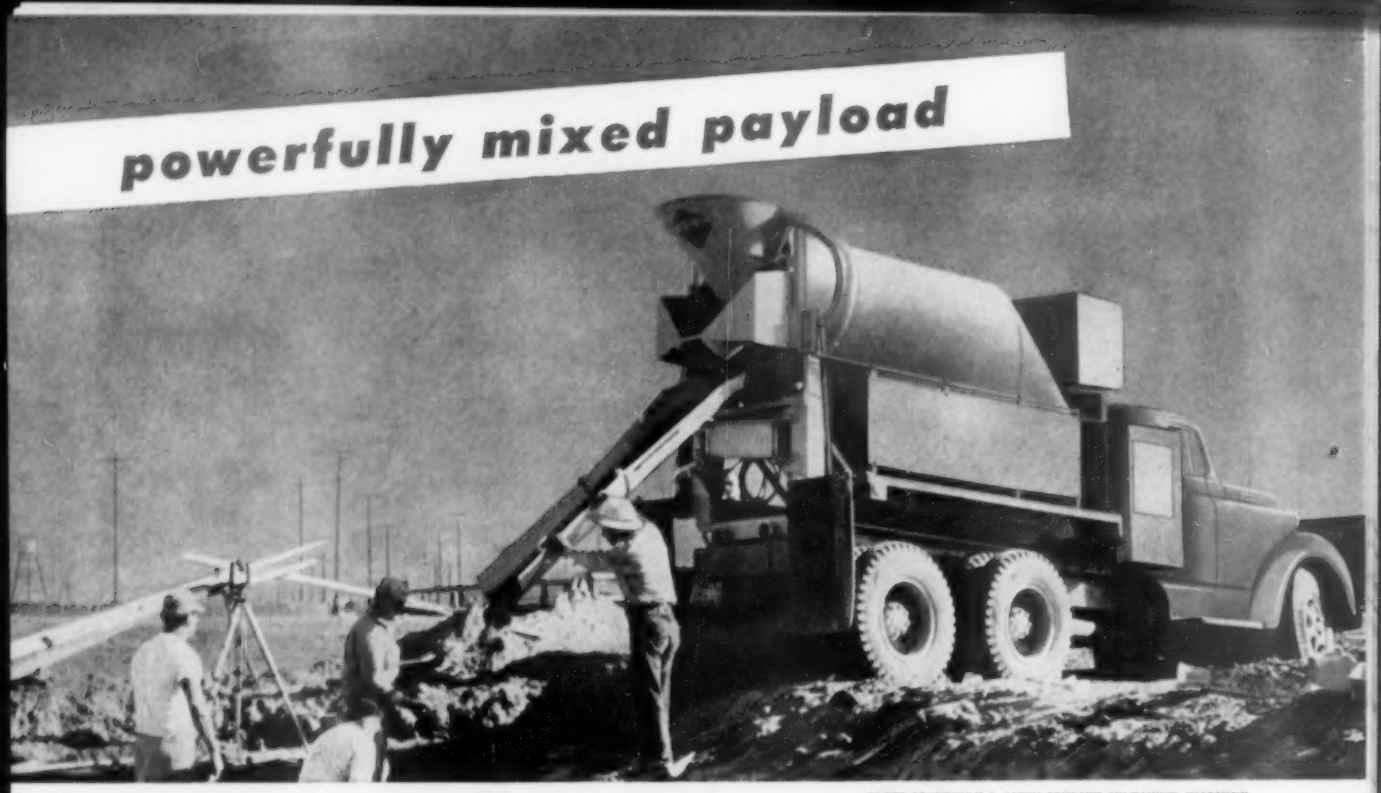
An understanding of the naphthalene molecule is an essential prerequisite to further calculations on naphthalene derivatives. The study of the vibrational frequencies of naphthalene has been satisfactorily completed, and two experimental studies were crucial in removing the last two obstacles to a useful assignment. A considerable portion of the assignment hinged upon the validity of the "oriented-gas" model used in the interpretation of the infrared spectra of single crystals.

To establish confidence in this model it was necessary to determine the assignments of a number of absorption maxima by an independent and reliable means. Careful repetition of the infrared study of naphthalene and naphthalene-d_8 in the gas state at elevated temperatures revealed band contours associated with rotational fine structure for several bands. These contours gave unambiguous assignments and provided enough information to corroborate the usefulness of the earlier interpretation.

The other obstacle to completion of the assignment was associated with the difficulty of accurate calculation of the thermodynamic properties without definite knowledge of the low-frequency motions. As mentioned previously herein, the low-frequency motions make such large contributions to the thermodynamic properties that precise assignments are extremely important. Unfortunately the spectral region in question is inaccessible to prism spectrometers. The grating spectrometer proved its value by permitting the detection of absorptions at 171 $cm.^{-1}$ and 362 $cm.^{-1}$ With these observations the matching of experimental and calculated thermodynamic properties was possible.

Terminal Deuterooctane

The calculations of the thermodynamic properties of aliphatic hydrocarbons depend rather heavily upon the potential function appropriate to the simplest homologous series, the normal paraffins. A considerable amount of



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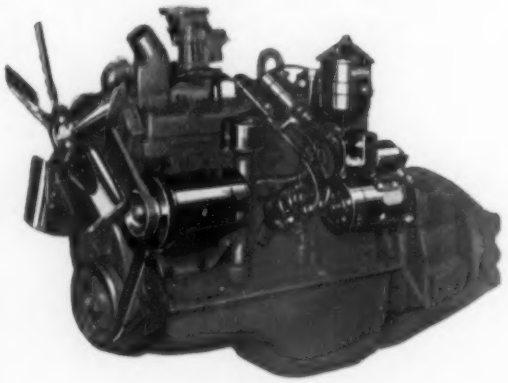

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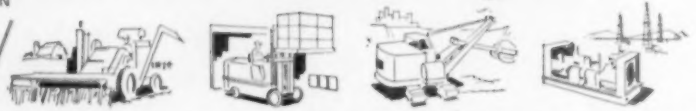

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American Petroleum Institute effort—both experimental and theoretical—has been aimed at clarification of the vibrational assignment of these straight-chain hydrocarbons. Normal coordinate calculations for a hypothetical infinite zigzag methylene chain finally figured in this assignment as an important contribution.

To establish the applicability of these calculations to hydrocarbons of finite chain length, the infrared study of terminal deuterooctane (n-octane-1,1,1,8,8,8-d_6) was undertaken. To be useful, it was necessary to obtain complete deuteration of the terminal methyl groups without any exchange or deuteration of the methylene groups. A. Streitwieser, Jr., devised and performed a synthesis of this compound.

A two-step reduction of suberic acid with lithium aluminum deuteride provided a compound of composition 91 per cent $C_8H_{12}D_6$ and 8 per cent $C_8H_{13}D_5$—ample purity for the purpose at hand. The infrared study was confined to the solid-state spectrum because the interpretation of the infrared spectra of liquid and gaseous hydrocarbons is complicated seriously by the presence of many rotational isomers.

The comparison of the spectra of solid n-octane and solid terminal deuterooctane verified the possibility of interpreting the vibrations of normal paraffins in terms of noninteracting methyl, methylene, and skeletal vibrations. The assignment based upon the infinite hydrocarbon was substantiated,[2] and a crucial test was provided of more detailed assignments of the lower straight-chain paraffins given by other workers.[3]

Properties of Fluids

Up to this point we have been considering data on single molecules which yield the thermodynamic properties of the substance in the ideal gas state. However, for practical purposes one usually is interested in the imperfect gas at a substantial pressure or in the liquid.

Correlation charts based upon the principle of corresponding states are commonly used to obtain differences in various functions from the ideal gas state. However, it is well known that this is only a rough approximation, inasmuch as substances generally fail to conform to the corresponding-states hypothesis.

Several years ago a sound theoretical basis was developed for the principle of corresponding states.[4] This made it possible to set forth the requirements in terms of molecular properties for conformity to this principle.

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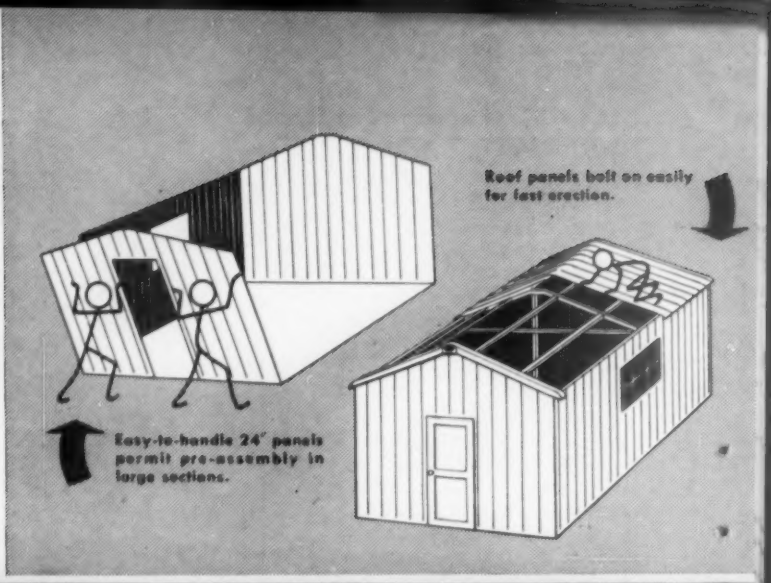

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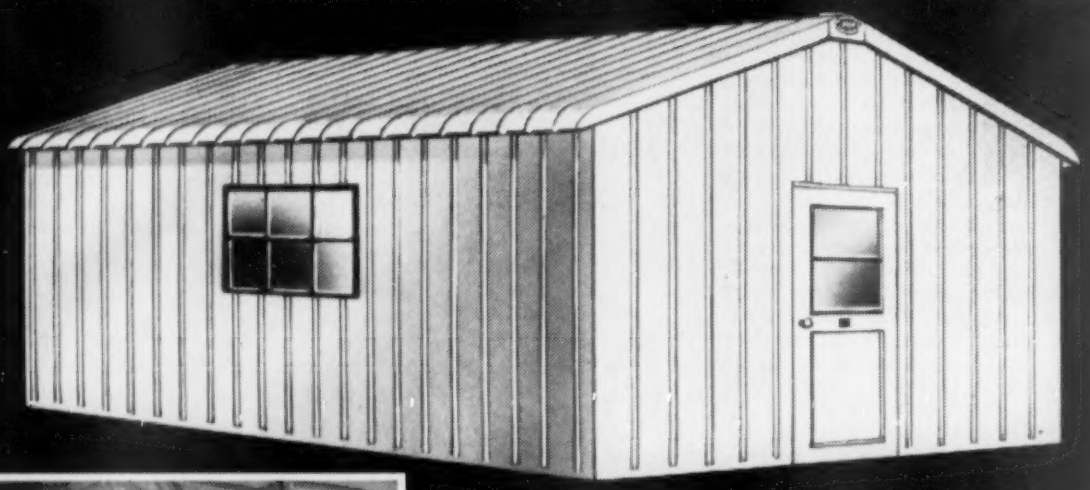

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It was found that only the heavier rare gases (argon, krypton, xenon), and possibly methane, could be expected to conform accurately to corresponding-states behavior.

These substances were called "perfect liquids." Briefly, the principal characteristics are effectively spherical shape and an inverse sixth-power attractive intermolecular potential. Strictly, one also must require the absence of quantum effects for molecular translation, but for practical purposes this involves only the extremely light molecules of hydrogen and helium.

Hydrocarbons other than methane deviate because of nonspherical shape or because the intermolecular potential arises effectively in the outer atoms rather than in the molecular center; i.e., the potential deviates from the inverse sixth-power law. It is found, both on the basis of limited theoretical studies and from empirical comparisons, that the effects of both of these types of deviation are essentially the same so far as volumetric or thermal properties are concerned.

Thus the nearly spherical neopentane molecule and the elongated n-butane molecule have essentially the same compressibility factor if compared at equal reduced temperatures and pressures. In other words, neopentane and n-butane obey the principle of corresponding states between themselves, but do not conform to methane or other substances in this respect.

The result of these considerations is to allow the prediction of the volumetric properties of a hydrocarbon if three parameters are known. The first two are the critical temperature and the critical pressure. The third is the deviation from the behavior of a perfect liquid, e.g., argon, krypton, xenon, methane. This third quantity we call the "imperfection parameter," η, and find it to be most readily determined by a vapor-pressure datum at any point well away from the critical point. Selecting a reduced temperature of 0.7 for convenience, the relationship is defined as:

$$\eta = \log (P_c/P_s) - 1 \qquad (1)$$

where:

P_s = the vapor pressure

P_c = the critical pressure

Fig. 1 shows the degree of conformity of various groups of substances to the system just described. It gives the compressibility factor as a function of the imperfection parameter, η. A series of reduced temperatures from 0.9 to 2.0, at the reduced pressure of 1.6, were selected as typical of the region where the compressibility factor is quite sensitive to the imperfection parameter. The

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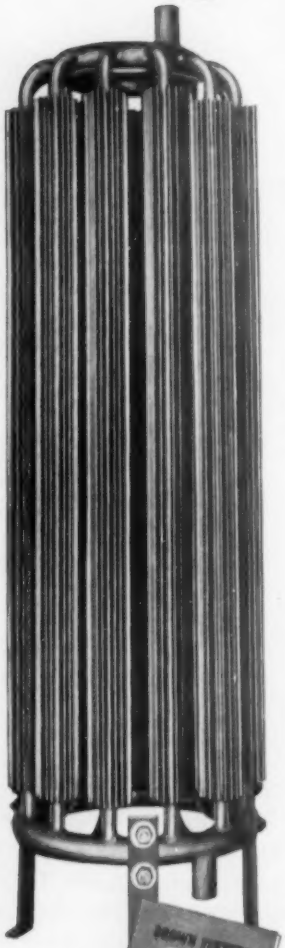

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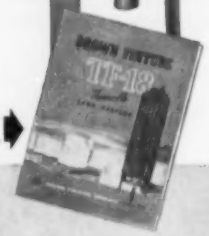

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points are for the groups of substances shown at the bottom of Fig. 1.

The substances within each group have substantially the same value of the imperfection parameter and, in accordance with our theory, conform to the principle of corresponding states within the group to about 0.004 in the compressibility factor. The open circles are for the highly polar substances, ammonia and water, which evidently do not follow the curves for the other substances. The solid circles fall on the curves within an average error of 1 per cent or less, whereas the variation with η often exceeds 10 per cent. Thus the present scheme represents an improvement of at least a factor of 10 over correlations based on simple corresponding-states behavior.

Work is currently under way on the development of extensive tables for the compressibility factor by graphical correlation of experimental data in terms of this principle. Also, A.P.I. Project 37 is cooperating in this program by testing this method with machine calculations using the Benedict equation. In the latter case each coefficient will be a function of the three parameters mentioned above for any particular substance.

This general theory of imperfect gas and liquid behavior also seems to fit molecules with small dipole moment such as hydrogen sulfide. Presumably it will encompass halogen derivatives of hydrocarbons, ethers, sulfur compounds, and the like. However, it is known that hydrogen bonds or high dipole moments yield behavior definitely in conflict with the scheme under discussion here. Both theoretical studies and the data for ammonia and water indicate this conclusion.

It will be noted that throughout the program of Project 50 theoretical knowledge of the forces within or between molecules is employed to guide the other work into fruitful paths. In the case of the imperfect gas and liquid studies, the final result is essentially empirical in nature. Nevertheless, a thorough understanding of molecular phenomena is needed.

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PROGRESS REPORT: A.P.I. Research Project 52

NITROGEN COMPOUNDS IN PETROLEUM

INCREASING awareness of the problems posed by nitrogen compounds in the refining of petroleum led to the establishment of A.P.I. Research Project 52, July 1, 1954. The work of this project is at three locations: University of Kansas at Lawrence, and the U. S. Bureau of Mines stations at Laramie, Wyo., and Bartlesville, Okla. Project directors are C. A. VanderWerf, J. S. Ball, and G. Waddington, respectively.

A study of the fundamental chemistry of nitrogen compounds, especially from the standpoint of developing separation processes which may be used to isolate individual compounds or groups of compounds, will be made by Project 52a at University of Kansas. Further work of this section will include the development of methods of synthesis for nitrogen compounds.

Separation of nitrogen compounds from a Wilmington, Calif., crude oil will be one of the first operations of Project 52b at the U. S. Bureau of Mines at Laramie. In addition, the preparation of highly purified nitrogen compounds for calibration standards and for the determination of physical and spectral properties will be done by this group.

Highly specialized measurements of the thermodynamic properties of the pure nitrogen compounds will be made by Project 52c at the U. S. Bureau of Mines at Bartlesville. These data will be used to calculate the heats and free energies of formation of these compounds.

As the store of fundamental information on the occurrence and properties of the nitrogen compounds in petroleum increases, industry will have the tools to make significant progress toward solving problems of catalyst poisoning, product instability, and fuel deposits, as well as progress toward the goal of learning how petroleum is formed.

Effect of nitrogen . . . Nitrogen compounds, even in trace amounts, cause serious problems in the processing of petroleum and in the storage of petroleum products. The following examples illustrate this conclusion:

1. The presence of nitrogen compounds reduces the activity of cracking catalysts. It has been demonstrated that these materials in catalytic charge stocks seriously decrease the conversion to gasoline.

2. Other catalysts—such as most of those used in reforming, polymerization, and isomerization — are highly susceptible to poisoning by nitrogen compounds.

3. Gums and precipitates formed in burner fuels in storage are relatively high in nitrogen. Certain nitrogen compounds are involved in their formation. For example, as little as 0.01 per cent of nitrogen as pyrrole markedly increases the rate of formation and the amount of insoluble gums formed on storage of fuel oils. Nitrogen compounds also are intimately connected with the formation of soluble and insoluble gums on the storage of diesel fuels. A definite correlation of gum formation and pyrrole content exists.

4. Nitrogen compounds in gasoline increase the formation of lacquer on the pistons and piston rings, and the gum deposits in the carburetor.

5. There is evidence that nitrogen compounds in trace amounts cause deterioration of the color of some petroleum products.

6. Some porphyrins (nitrogen-metal complexes) are volatile and on distillation introduce metal poisons into catalytic feed stocks.

7. The refining of shale oil, which may become important in the future, will accentuate these problems because of the higher nitrogen contents of shale oils.

Origin of petroleum . . . In addition to aiding in the solution of the foregoing problems, a better knowledge of the nitrogen compounds in petroleum would be useful in the determination of petroleum's origin. The constancy of the ratio of basic to total nitrogen in a wide variety of crude oils indicates a common mechanism for their formation. Microbiological evidence further suggests that the nitrogen compounds originated in protein materials.

The porphyrin compounds are fingerprints of the source material of petroleum, and are analogous to hemoglobin, chlorophyll, and other metabolic pigments of plants and animals. The porphyrin compounds are extremely stable at temperatures below 300° F., and hence have probably resisted decomposition through geological ages. Thus these materials may contribute much to an understanding of the origin of petroleum.

A better knowledge of the structure of porphyrins may be useful in the recovery of petroleum. For example, a recent paper reports that the porphyrins and related compounds show a high degree of interfacial activity and film formation at the oil-water interface, and this may be of tremendous importance in the wettability of the petroleum-reservoir rocks and in the secondary recovery of petroleum.

Current Knowledge

At this point it might be well to review briefly present knowledge concerning nitrogen compounds in petroleum.

1. The nitrogen content of crude oils ranges from traces to as much as 0.9 per cent by weight in some California crude oils. In general, the more asphaltic the crude oil, the higher the nitrogen content. The nitrogen content of crude-oil fractions increases rapidly with increased boiling point.

2. Most of the nitrogen is present in a form which cannot be extracted with dilute acid. A portion of this nitrogen is combined in porphyrin structures.

3. The nitrogen in crude oil and distillates is present in both basic and nonbasic forms. Only pyridine and quinoline homologues have been identified among the basic constituents boiling below 600° F., and only pyrrole types have been identified in the nonbasic portion. The identity of most of the low-boiling nitrogen compounds is still unknown, even as to type. Essentially nothing is known about the nitrogen compounds in the fractions boiling above 600° F. Those compounds identified in petroleum are listed in Table I.

4. Reliable physical data on the properties of the types of nitrogen compounds known or suspected of occurring in petroleum are very meager and are largely confined to the lower-boiling pyridines and quinolines. Accurate spectrographic and thermodynamic data are almost nonexistent. Some parts of the industry already are concerned with problems induced by nitrogen compounds, and they are finding a lamentable shortage of fundamental data.

5. The chemical behavior of the nitrogen compounds suspected of being present in petroleum is little understood. This is particularly true of the nonbasic compounds such as pyrroles.

Adapted from report presented at annual meeting, A.P.I., Chicago, November 8, 1954.

A.P.I.—Research Project

Knowledge inadequate . . . In summary, it may be said that the petroleum industry knows very little about the nitrogen compounds which are present in distillates and even less about those present in crude oils. Fundamental data on the properties and reactions of the nitrogen compounds known or suspected of being present are inadequate for scientific study and for development of practical means to solve or circumvent the problems caused by nitrogen which are facing the industry today.

Furthermore, these problems will become even more acute in the future as process charge stocks are taken from heavier portions of the crude oil, and as the reserves of paraffinic and naphthenic crude oils decrease, requiring the processing of more of the asphaltic-type stocks.

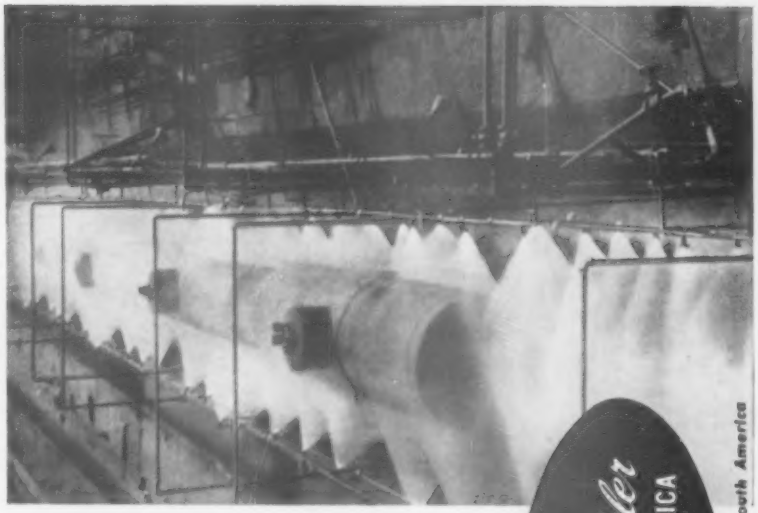
Greater problem . . . During recent years we have witnessed an increasing trend toward cutting deeper into crude oil for the preparation of catalytic-cracking charge stocks. Whatever scheme is used—high-vacuum distillation, vacuum flashing, viscosity breaking, or coking—the harmful effect of nitrogen is accentuated because of the greater amount of nitrogen compounds in the heavy ends. This is true even for low-nitrogen crude oils.

An appreciation of the inhibiting effect of nitrogen in catalytic cracking has revived the industry's interest in the nitrogen constituents of petroleum. The poisonous effect of nitrogen compounds on various reforming catalysts, and the harmful effect of small concentrations of certain nitrogen compounds on product quality, have further stimulated this interest. The foregoing reasons motivated the American Petroleum Institute to establish Project. 52.

Identification of Compounds

Careful studies have shown that, no matter how the total nitrogen content may vary, the ratio of basic to total nitrogen for crude oils is 0.30 ± 0.05. Despite the decided predominance of so-called "nonbasic" nitrogen compounds in petroleum, more than two-score basic nitrogen-containing compounds have been isolated from petroleum distillates and identified, whereas the complete isolation and positive identification of the first nonbasic nitrogen compound in petroleum is still awaited.

Ball and co-workers have succeeded in isolating a number of pyrroles from shale oil, and the presence of carbazoles, indoles, and pyrroles in a catalytically cracked and a virgin oil distillate has been indicated in a recent



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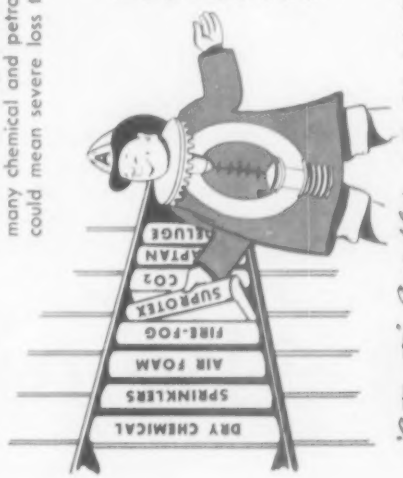

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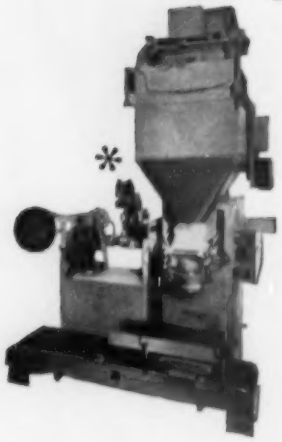

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mass spectrometric study. However, knowledge of specific nonbasic nitrogen constituents of petroleum is exceedingly meager.

These facts suggest that these nonbasic compounds constitute a logical starting point for a study of the chemistry of the nitrogen compounds in petroleum, all the more so because it is chiefly to these compounds that the adverse effects on storage stability on color, and on pistons, piston rings, and carburetors are attributed. Therefore, it is with the chemistry of these nonbasic nitrogen compounds that Project 52a will be initially concerned.

The reason why the nonbasic compounds have been slighted thus far is obviously that they are less tractable than their more basic counterparts. They do not succumb to the usual extraction with acids. But actually the description "nonbasic" is only relative, and these nitrogen compounds do retain a certain degree of basicity. Indications are that they can be extracted with concentrated sulfuric acids and with liquid sulfur dioxide.

The first attack on these compounds will be a fundamental study of those properties which may be of value in their segregation from the other constituents of petroleum and, ultimately, in the isolation of individual compounds in pure form.

Separation . . . The second phase of the work of Project 52a will be an attempt to separate these compounds, first from synthetic mixtures, and then from samples of concentrates supplied by the section of this project at the U.S. Bureau of Mines in Laramie.

At the same time, ultraviolet and infrared spectrophotometric studies will be made whenever necessary on the various types of pure compounds and on mixtures, so that the progress of the separation and isolation processes can be followed readily. Cooperation from industry in the carrying out of raman and mass-spectra studies will be sought. Also attempts will be made to apply standard chemical methods and to develop new chemical methods for characterization of various isolated fractions.

The third phase of the program of Project 52a is the small-scale synthesis of nitrogen-containing compounds which occur in petroleum. The synthetic phase of the work will be aimed at the extension of our fundamental knowledge concerning the reactions of nitrogen compounds, at the preparation of samples for the "small-sample" program, and at the development of tested synthetic methods which may be em-

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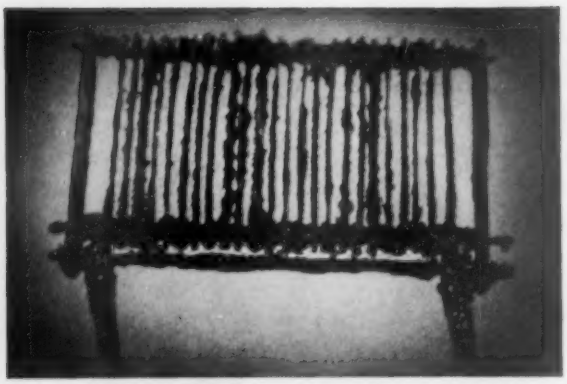

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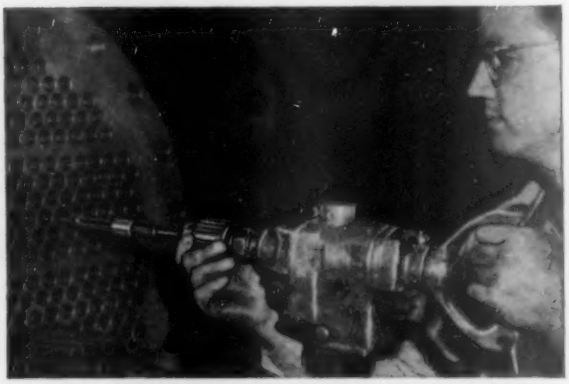

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ployed for large-scale synthesis in Project 52b.

The establishment of the identity of the nitrogen compounds in petroleum requires that work be done along two lines, viz.: (1) the concentration and isolation of the nitrogen compounds from a sample of petroleum; and, (2) the preparation of nitrogen compounds in high purity and the determination of their physical and spectroscopic properties.

The identification of the compound from petroleum can then be established ideally by comparison of properties with the purified compound. Because of the small amounts of nitrogen present in petroleum, and the vast number of nitrogen compounds which might be present, it will be necessary to compromise on this procedure in some instances.

Crude selected . . . The advisory committee and directors of the project have selected Wilmington, Calif., crude oil for the initiation of work. Through the assistance of California Research Corp., a sample of 12 bbl. of this crude oil has been obtained by the project.

It is planned initially to prepare nitrogen concentrates by chromatographic separation. In the early experiments, at least, the asphaltenes will be removed first in order to facilitate the separations. Short studies are under way to determine the best techniques and solvents for removal of asphaltenes.

The second approach—that of purification of nitrogen compounds and the determination of physical and spectroscopic properties—is expected to proceed at a rate which will produce three compounds per year. The program of purification is based on the premise that pyrrole and pyridine types will be predominant in petroleum and on the desire of the project to place as great emphasis as possible on the nonbasic or pyrrole-type compounds.

Purification . . . Purification will be accomplished primarily by distillation, although other separation procedures such as solvent extraction, chemical treatment, adsorption, and thermal diffusion may be employed on occasion.

Determination of purity will be accomplished by means of the freezing-point method.

In order to speed the accumulation of spectral data for identification purposes, an abbreviated program called the "small-sample" program will be inaugurated. Acquisitions of nitrogen compounds—either by donation from outside the project or by synthesis within the project—may be added to this program if the quantity is 50 ml.

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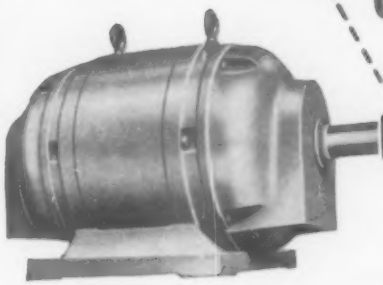

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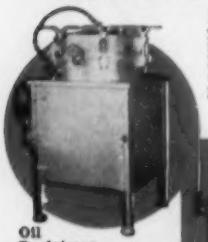

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or more. The project will attempt to improve the purity by one distillation and to estimate the purity. A sample of the "best fraction" will be submitted to one of the petroleum-company spectroscopic laboratories for measurement of spectra. Some measurement of physical properties also will be attempted. Already donated for this program are 10 samples. The spectra will be made available through the catalogs of A.P.I. Research Project 44.

Thermodynamics . . . A survey of the chemical literature has shown that accurate thermodynamic data have been published for only a few nitrogen-containing compounds. Although the search was concerned primarily with heterocyclic compounds, the same conclusion as to lack of thermodynamic data probably is valid for all families of organic nitrogen compounds.

It was found that complete thermodynamic data are not available for any of the important five and six-membered ring compounds of nitrogen, although limited thermodynamic data—generally not of the highest accuracy—have been published for pyrrole, pyridine, quinoline, piperidine, and a-picoline. Recently some physical properties of pyridine and its methyl derivatives have been studied at the Chemical Research Laboratory, Teddington, England, as part of a program related to coal-tar derivatives.

The aim of Project 52c will be to make comprehensive studies of the thermodynamic properties of each nitrogen compound of interest, insofar as these properties are not available in the literature.

It is expected that previous research experience of the staff of the Bartlesville laboratory on sulfur compounds will improve the efficiency of nitrogen-compound investigations. For example, detailed experimental and statistical mechanical studies have been made of the sulfur compounds thiophene and thiacyclopentane. These two compounds are the sulfur analogues of pyrrole and pyrrolidine. It is to be anticipated that similarities in the spectra of the corresponding sulfur and nitrogen compounds will facilitate computation of thermodynamic functions for the nitrogen compounds.

One of the important criteria imposed on modern thermodynamic studies is that the sample of compound being investigated shall be of the highest purity. The present lack of cyclic nitrogen compounds of standard-sample quality will prevent initiation of actual measurements until such time as the Laramie group has completed purifi-

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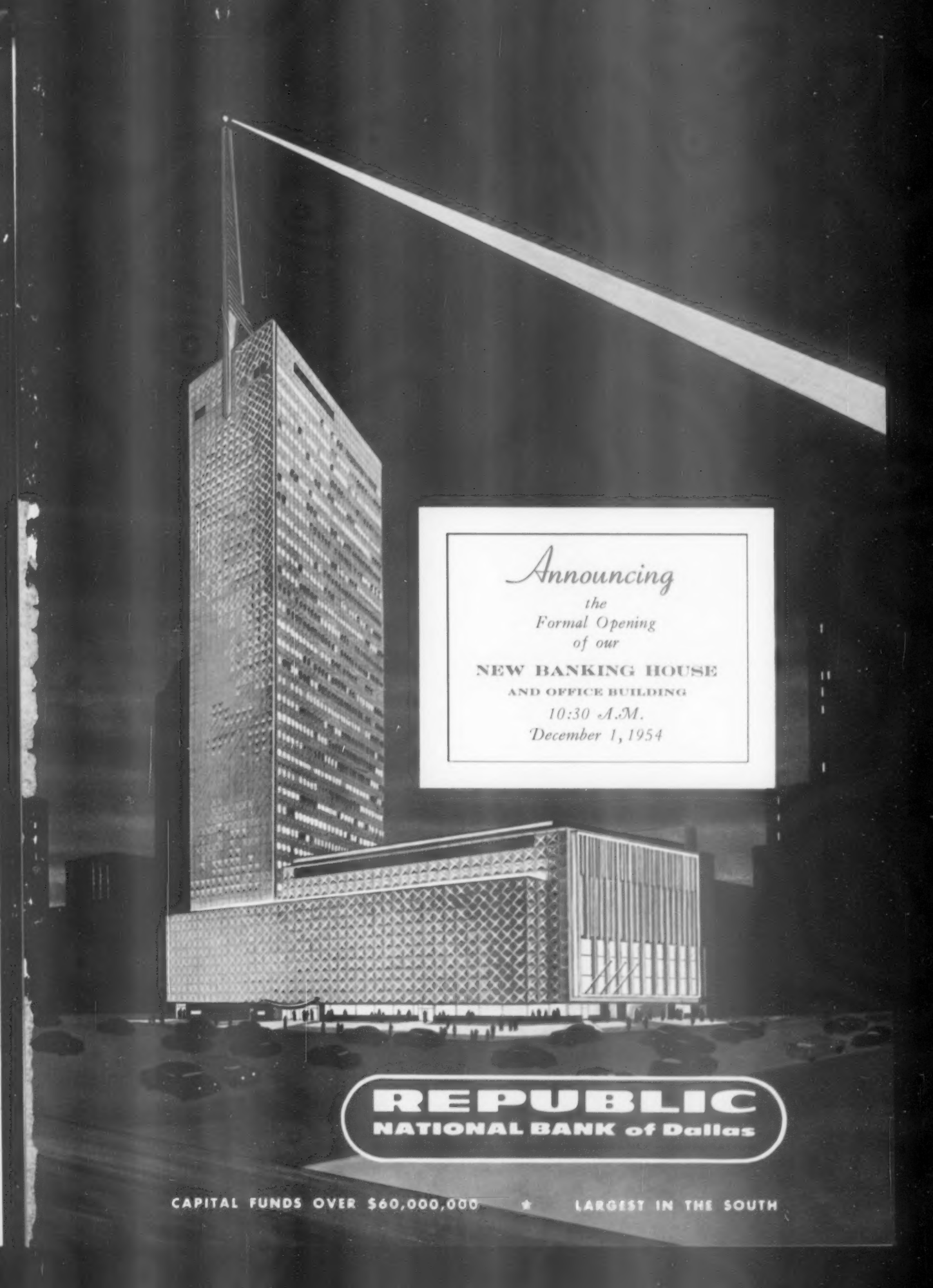
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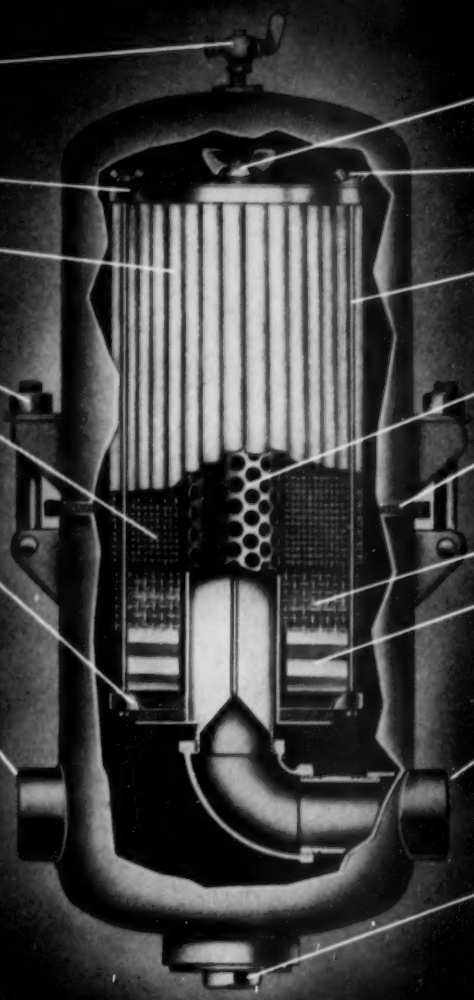

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cation of several of the compounds to be studied.

It is not anticipated that many changes will have to be made in apparatus and procedures for study of nitrogen compounds, although it is possible that the moderately high boiling points of some of the compounds, the chemical reactivity of the pyrroles, the basicity of the pyridines, and the generally greater hydroscopicity of all of the compounds will introduce problems.

TABLE 1

Nitrogen Compounds Isolated from Petroleum

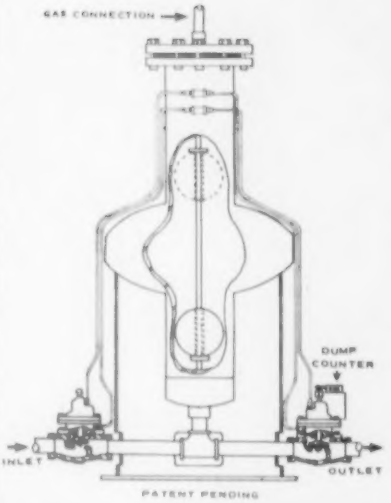
Compound	Isolated from
Pyridines	
2-Methylpyridine	A,B
3-Methylpyridine	B,C
4-Methylpyridine	A,B
2,3-Dimethylpyridine	B,C
2,4-Dimethylpyridine	B,C
2,5-Dimethylpyridine	B,C
2,6-Dimethylpyridine	B,C
3,4-Dimethylpyridine	B
3,5-Dimethylpyridine	A,B
2,3,4-Trimethylpyridine	C
2,3,5-Trimethylpyridine	C
2,3,6-Trimethylpyridine	B
2,4,6-Trimethylpyridine	A,B
4-Ethylpyridine	B
2-Methyl-4-ethylpyridine	B
2-Methyl-5-ethylpyridine	B
2-Methyl-6-ethylpyridine	B
3-Methyl-5-ethylpyridine	C
3-Ethyl-5-methylpyridine	C
3-Cyclopentylpyridine	C
4-Cyclopentylpyridine	C
2,3-Dimethyl-6-isopropylpyridine	C
dl-2-sec-Butyl-4,5-dimethylpyridine	C
2-(2,2,6-Trimethylcyclohexyl)-4,6-dimethylpyridine	C
Quinolines	
Quinoline	A,B
2-Methylquinoline	A,B
3-Methylquinoline	B
4-Methylquinoline	B
7-Methylquinoline	B
8-Methylquinoline	B
2,3-Dimethylquinoline	C
2,4-Dimethylquinoline	C
2,8-Dimethylquinoline	B,C
2,3,8-Trimethylquinoline	C
2,4,8-Trimethylquinoline	C
2-Methyl-8-ethylquinoline	C
2,3-Dimethyl-8-ethylquinoline	C
2,4-Dimethyl-8-ethylquinoline	C
2,4-Dimethyl-8-sec-butylquinoline	C
2,3,4,8-Tetramethylquinoline	C
2,3-Dimethyl-8-n-propylquinoline	C
2,4-Dimethyl-8-n-propylquinoline	C
2,3,4-Trimethyl-8-ethylquinoline	C
2,3,8-Trimethyl-4-ethylquinoline	C
2,3,4-Trimethyl-8-n-propylquinoline	C
2,3,4-Trimethyl-8-isopropylquinoline	C
2,3-Dimethyl-4,8-diethylquinoline	C
2,3-Dimethyl-4-ethyl-8-n-propylquinoline	C
2,3-Dimethylbenzo(h)quinoline	C
2,3-Dimethylbenzo(h)quinoline	C
Isoquinolines	
Isoquinoline	B
2-Methylisoquinoline	B
3-Methylisoquinolines	B
Others	
Methylindole	D
5,6,7,8-Tetrahydroquinoline	C

A = Cracked gasoline from California petroleum.

B = Cracked distillate from California petroleum.

C = Straightrun kerosine from California petroleum.

D = Crude residuum from California petroleum.



ROLOCHECK

Trade Mark

The New Oil Well Meter

A new oil well meter has been developed which is simple in design, yet very accurate and eliminates expensive maintenance problems caused by gas, sand and other solids in crude oil. The meter has a high maximum rate and features a zero minimum rate. The new Model No. RM 1-24 will handle as much as 1,440 bbl. per day at 12 psi.

Gas and sand will not affect the new meter any more than they would affect normal control valves in oil lines. The meter actually dumps a positive calibrated dump each time. It may be installed on existing heater-treaters, vertical or horizontal separators. The Rolocheck meter eliminates liquid level controls on the separator as it actually controls the liquid level in the vessel.

OPERATION

(1) **Filling:** When float hits lower stop, pilot trips to close outlet valve and open inlet valve simultaneously.

(2) **Dumping:** When float hits upper stop, pilot trips to open outlet valve and close inlet valve simultaneously.

ACCESSORIES

GAGE COCKS, GLASS, & GUARD RODS
0-200° THERMOMETER & WELL

SPECIFICATIONS

TYPE	RM 1-24
WORKING PRESSURE	150 PSI
CAPACITY B.P.D.	MIN. -0- MAX. -1440*
HEIGHT	4'-6"
WIDTH	2'-0"
WEIGHT	356 LBS.
GAS CONNECTION	1"
OIL OUTLET	1½"
OIL INLET	1½"

**At 12 psi. pressure differential. Available with 2" valves for greater capacity.*

ROLO MANUFACTURING COMPANY

P. O. Box 6763,
Houston 5, Texas

BRANCHES: Corpus Christi, Midland, Kilgore, Tulsa, New Orleans, Los Angeles, Casper, Mt. Vernon (Ill.); Lima, Peru; Caracas, Venezuela (PETICON).

EXPORT OFFICE: R. S. Stokvis & Sons, Inc., 17 Battery Place, New York, New York.

NOW MORE THAN EVER BEFORE . . .

an Aggressive Bank

is an important part of your Oil Operation

You are cordially invited to consult with our Oil and Gas Division

THE CITY NATIONAL BANK OF HOUSTON

CAPITAL AND SURPLUS 15 MILLION DOLLARS

Member Federal Deposit Insurance Corporation

EQUIPMENT MEN . . . in the News

Childs Is Sales Engineer For Coastal Engineering

G. C. CHILDS

The appointment of George C. Childs as sales engineer for Masoneilan & Smith Meter Division of Coastal Engineering Corp., New Orleans, has been announced by C. E. Naylor, president of the corporation. For the past 6 years, Childs has successively been process engineer, project engineer, and staff and instrument engineer for Firestone Tire & Rubber Co.'s synthetic-rubber plant at Lake Charles, La.

Child's territory for Coastal Engineering will include all of southern Louisiana.

Oilwell's Rocky Mountain District Announces Changes

Appointment of three store managers and two representatives in the Rocky Mountain area of U. S. Steel's Oil Well Supply Division have been announced by R. L. Armstrong, area manager.

Store managers are Paul E. Shea, named manager of the Fort Morgan, Colo., store; Robert W. Anderson, who succeeds Shea as manager of the Cut Bank, Mont., store; and Donnie E. Bowers, who becomes manager of the Glendive, Mont., store.

Representatives are Frank J. Long as field representative at Casper, Wyo., and Robert C. Craig as city representative at Denver.

Shea was employed by Oilwell in 1945, at Cut Bank, where he has served as store manager since 1949; Anderson joined Oilwell in 1952 at Casper; and Bowers became associated with the division in 1952 at Powell, Wyo., and has served as field representative at Glendive since 1953.

Long joined Oilwell in 1949 at Casper. Since that time he has held various sales and managerial positions at Glendive, Williston, N. D., and Fort Morgan, where he was located prior to his new assignment.

Craig has been employed by Oilwell since 1945 and prior to his newest appointment has held various sales and managerial positions at Artesia, Colo.; Billings, Mont., and Worland and Casper, Wyo.

One of the recent log-interpretation schools was held in Oklahoma City. Over 10 companies had representatives attending on the day this photograph was made.

Logging Course Attracts Interest

Response to a series of 1-day basic log-interpretation schools currently held in the Mid-Continent area has surprised its service-company sponsor. Geologists, petroleum engineers, oil producers, and laymen attend the courses.

The students review fundamentals of logging and work with typical logs, using a text prepared specifically for the course. Over a year's research on commonly encountered logging problems preceded introduction of the course.

"Charts for Log Interpretation" is the basic text. It was prepared by Halliburton Oil Well Cementing Co.'s electrical well-services research laboratory at Houston. This text contains all the information necessary to calculate porosity, water saturation, formation factor, and true resistivity from electric and contact logs.

Use of slide projectors and blackboard lectures supplements the printed material used. The instructor in each course is assisted by other service-company personnel, enough to give individual attention to each student.

Individual attention is received as an instructor checks students' progress.

Socony-Vacuum Awards Fluor Contract for Modification

The Fluor Corp., Ltd., Los Angeles engineering, construction, and manufacturing firm, has been awarded a contract for the design, engineering, and construction of a new 20,000-bbl. per day Sovaformer unit and a prefractionating unit for Socony-Vacuum Oil Co., Inc., at its Paulsboro, N. J., refinery.

Preliminary work will get under way immediately by Fluor's Mid-Continent engineering division at Houston. Completion of the project is scheduled for July 1955.

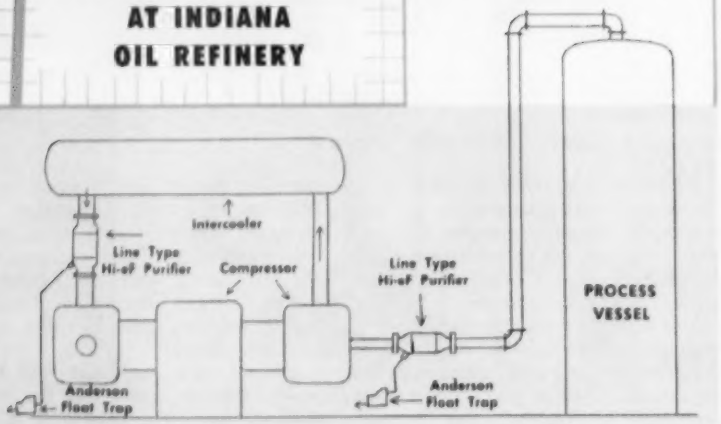
Fluor will convert an existing ther-

ANDERSON Hi-eF PURIFIERS

CASE STUDY

PURIFIERS REPLACE PACKED TOWER IN COMPRESSOR SERVICE AT INDIANA OIL REFINERY

No. 108



EQUIPMENT REQUIRED:

Hi-eF Low Pressure Line Purifier (Type LS16 Stainless Steel Construction)

SERVICE:

Installed in 18" line to remove damaging water, liquid, hydrocarbons, and corrosive liquid mist entrained in 1400 SCFM of wet hydrocarbon gas at 20" of water vacuum and 140° F. This installation is in the WET GAS COMPRESSOR SUCTION LINE and operates with a maximum pressure drop of 4.3 inches of water at the load conditions stated.

RESULTS:

This Hi-eF Purifier, by automatically removing liquid carry over as well as corrosive mist entrainment, gives continuous and complete protection to the compressor, one of the most vital components of this process. In addition, the Hi-eF Purifier saves the refiner considerable money since it costs far less than a packed tower, which had corroded beyond its safe operating limits. Anderson engineers are specialists in solving difficult entrainment problems. We welcome your inquiry.

Hi-eF Purifiers

THE V. D. ANDERSON COMPANY
Subsidiary of Chesapeake Industries Inc.
1992 West 96th Street • Cleveland 2, Ohio

Please send me additional information on protecting compressors with Hi-eF Purifiers.

Name _____ Title _____

Company _____

Address _____

City _____ State _____

Keep dirt, moisture and liquids out of steam, vapor, air and gas lines and processes.

mal-reformer unit with gas-recovery and treating facilities into the prefractionating unit, which will operate with 14,500 bbl. per day of naphtha feed. The section will produce 1,600 bbl. per day of butanes, 4,700 bbl. per day of light straightrun gasoline, and 8,200 bbl. per day of naphtha.

The Sovaformer stabilization section will operate with 20,000 bbl. per day of naphtha feed, producing fuel gas, propane, butane, and stabilized reformate.

M. M. & M. Adds Jack Gates As Product Sales Engineer

J. L. GATES

Jack L. Gates has been added to the staff of product sales engineers of Manning, Maxwell & Moore, Inc., according to a recent announcement. Gates' primary responsibility will be to support and assist district offices in the Southwest in selling the firm's electronic process-control instruments. Karl W. Peterson, product manager, American-Microsen Instruments.

Gates has been with Standard Oil Co. (N.J.), the U. S. Government's petroleum administration, and from 1945 to 1948 has been manager of Bryon Jackson Co.'s Chicago branch. More recently he has been assistant chief instrument engineer with Girdler Co., Louisville, Ky.

In his new assignment, Gates will work out of the Houston district office of Manning, Maxwell & Moore.

Bennett To Manage Dallas District for Twin Disc

E. H. BENNETT

Appointment of E. H. Bennett to district manager of the Twin Disc Dallas branch has been announced by Twin Disc Clutch Co., Racine, Wis. Bennett is replacing H. A. Davis, who has resigned to organize his own business in Dallas. Bennett is already well known throughout the Dallas area, having been assistant district manager of the Dallas branch from 1945 to 1947. He has been a member of the Twin Disc sales and service department in the Tulsa branch from 1942 to 1945. Prior to his new appointment he was district manager of the Twin Disc Newark branch.

McAneny Appointed To Key Post By M. W. Kellogg Co.

John M. McAneny has been appointed manager of the sales administration department of M. W. Kellogg Co., a subsidiary of Pullman, Inc., designer and builder of chemical plants and oil refineries. A chemical engineer, McAneny has been associated with Kellogg for 12 years in various supervisory capacities for sales and promotional activities.

Prior to joining Kellogg, he began his professional career with Tide Water Associated Oil Co. for 14 years, starting as a research chemist and advancing through sales engineering to district sales manager.

Tube Turns Announces Sales Reorganization

John G. Seiler, executive vice president and general sales manager of Tube Turns, Louisville, Ky., has announced the reorganization of the company's sales department.

According to Seiler, the reorganizational move has been designed to improve marketing procedures and customer services, and to recognize the special capabilities of various members of the sales staff to whom many new duties have been assigned.

John E. Chumbley, Jr., assistant general sales manager, now administers sales policies and sales of welding fittings and flanges in the United States, and also supervises forging sales. Thomas H. Pike, Jr., merchandising manager, now supervises merchandising activities of the Louisville general sales office, and has supervision of the Houston and Los Angeles plants and the engineering service division.

Jack W. Green, executive assistant, has charge of all sales policies and projects for Canada, foreign sales, conventions, shows, and exhibits. Charles F. Morris is sales manager of the forgings division. Lincoln D. Hall, formerly manager of the Tulsa office, has become assistant sales manager and now administers sales policies and sales in the Tulsa, Houston, and West Coast territories.

Elmer H. Dilley now is manager of the general sales office and supervises the handling of inquiries and quotations, registration and entry of orders, special fittings, inventories and inventory control, order scheduling, and other functions. H. Dewey Gass, Jr., is manager of the order service de-

Trap Users Everywhere Are Excited About NEW HEAT-KWIK Super-Silvertop STEAM TRAPS

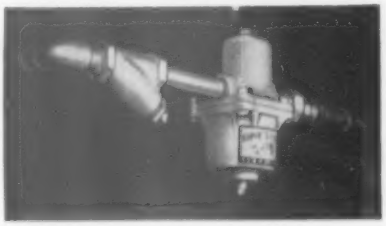
...world's fastest venting inverted bucket steam trap

Save Hundreds of Dollars...
You save production time by venting air out of steam consuming units 8 times faster than possible with ordinary inverted bucket traps.

Save on Fuel...
Purges air all at once so that unvented air cannot mix with steam entering steam compartment, thereby reducing the temperature and acting as heat insulator.

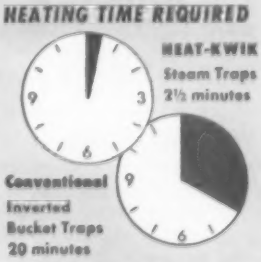
Use Smaller Traps...
Only necessary to use a 1½ trap factor in most instances, never more than 2. This means smaller sized traps can be used.

Save on Trap Repairs...
Bellows orifice does not contract continually, like in thermostatic trap, but remains closed until it cools off. This means long bellows life.



FREE NEW Heat-Kwik Bulletin. Mail Coupon Below.

HEATING TIME REQUIRED

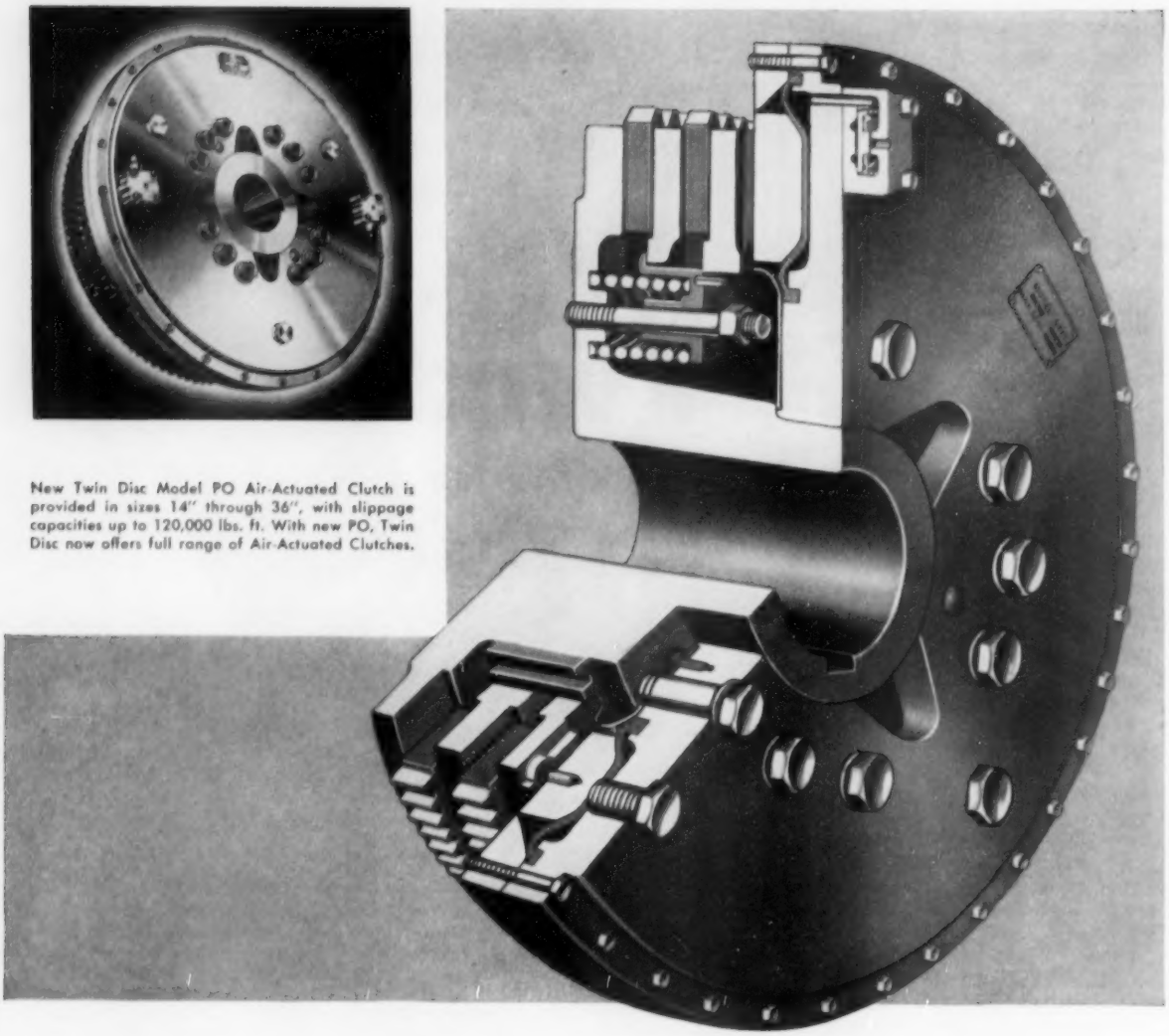


THE V. D. ANDERSON COMPANY
1981 West 96th Street • Cleveland 2, Ohio

Gentlemen: Please send me the new Heat-Kwik catalog without obligation.

Name ..... Title .....
Company .....
Address .....
City ..... State .....

New Twin Disc Model PO Air-Actuated Clutch is provided in sizes 14" through 36", with slippage capacities up to 120,000 lbs. ft. With new PO, Twin Disc now offers full range of Air-Actuated Clutches.



New Twin Disc Air-Actuated Clutch designs offer higher torque, narrower width, less weight

Lighter, more compact remote control of power transmission without complicated linkage . . . a requirement voiced throughout the drilling industry by both the user and the manufacturer of powered equipment . . . and a requirement *met* by one of the newest additions to the Twin Disc line of Air-Actuated Clutches.

Developed expressly for heavy-duty installations, the Twin Disc Model PO's advanced design features offer outstanding advantages. Highlighting these advantages are:

1. *Reduced initial installation cost, in many instances, through use of smaller size clutches . . . provided by the greater torque capacity, up to 120,000 lbs. ft.*

2. *Less shock-loading during starting cycles, permitting use of smaller driven components . . . provided by the Model PO's lighter weight which reduces inertia mass.*

3. *More compact installation . . . provided by the narrower width . . . permitting the Model PO to be used where, previously, drum or band style clutches with larger diameter and higher inertia were the only solution.*

4. *Faster, smoother operation under all working conditions; no seal drag.*

5. *Positive, quick release provided by exclusive Twin Disc diaphragm design — fully-supported, with no-stretch construction—and with extra-long stroke and controlled flexing.*

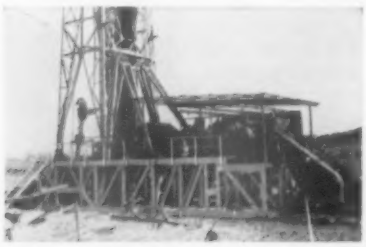
6. *Long, trouble-free operating life, with extra-large passages from cored back plate providing "air-flow" cooling to the diaphragm insulator plate, springs, and driving plates.*

Major economies in servicing have been provided . . . the entire clutch can be stripped to the last piece in less than five minutes . . . and replacement parts are minor components, extremely low in cost. Ideal for replacement on older installations, too.

Write today to Twin Disc Clutch Company, Racine, Wisconsin, and request Bulletin 304 for full information, or call Factory Branch at Dallas (Riverside 3014), or Tulsa (4-1578), or Los Angeles (Logan 8-3309).

Air-Actuated Clutches prove adaptability in the oilfields

For greater efficiency and longer working life, the new Brewster N-95 Drawworks standardizes on Twin Disc Model PO as working clutches, with a 3-plate 30" on the low drum, 2-plate 30" on high drum, and 3-plate 24" as master clutch.



Three Twin Disc Air-Actuated Clutches are used for high torque at low speeds on this Emsco GB-800 Drilling Rig. Twin Disc Air-Actuated Clutches include 3-plate 18" on rotary table, 3-plate 27" on high drum, and 3-plate 24" as master clutches.

TWIN DISC

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin
Hydraulic Division, Rockford, Illinois

partment and works closely with Dilley.

Dan R. Cheyney is assistant manager of the engineering service division, in charge of alloys. Jack D. Tolliver is assistant manager of the engineering department, in charge of pipeline business.

Two new committees have also been formed. One, the sales-planning committee, directed by Seiler, will map out sales plans and tie in advertising and public relations with sales objectives. The other, the branch-plant committee, will shape management policies affecting branch plants. It is headed by Pike.

Oliver Joins Wheland Staff At Chattanooga

JOHN OLIVER

John Oliver has joined the staff of Wheland Co., Chattanooga, Tenn., as special assistant to Gordon P. Street, president. Oliver's primary interest will be in the expanding oil-field activities of the company and in the development of new markets and products for the concern.

From 1942 until his resignation to join Wheland's staff, Oliver was associated with Tennessee Valley Authority where he was appointed general manager in 1951.

Bethlehem Makes Mitchell Shreveport Store Manager

The promotion of W. Q. Mitchell to store manager of the Shreveport, La., store has been announced by Bethlehem Supply Co. Mitchell has been with Bethlehem for 24 years and has had considerable experience in the oil-field-supply business in East Texas and northern Louisiana.

Mitchell was store manager at Winnsboro, La., for 5 years before being transferred to Shreveport in July 1953 as assistant store manager of the Shreveport store. This was the position he held prior to his promotion.

Ramsey Promoted To Key Post By Dowell

Dowell Incorporated, oil-well service firm, has promoted D. E. (Pat) Ramsey to the newly created position of manager of operations in the company's general offices in Tulsa. Ramsey has been district manager of Dowell's West Texas operations with headquarters at Midland. He will assume his new duties January 1, 1955.

There is no safer, longer lasting chain than

CAMPBELL

- Spinning Chains
- Boomer Chains
- Winch Line Chains
- Proof Coil Chain
- BBB Coil Chain
- High Test Steel Chain
- Cam-Alloy Steel Chain

When you order chain from your supply store, always specify CAMPBELL

CAMPBELL CHAIN *Company*
York, Pa. and West Burlington, Iowa

Warehouse stocks:
Houston, Texas
Sacramento, Calif.

CAMPBELL CHAIN

Makers of Famous *Lug-Reinforced* TIRE CHAINS

OCECO Internal TANK VALVES

prevent "run-offs" from storage tanks

• Valve is held open with a lever, and a fusible link that melts when exposed to grass fires, etc., permitting a spring to close the valve tightly, cutting off the flow. Fabricated steel construction. Free flowing design. Mounts on standard single flange tank nozzle. 3 inch to 18 inch sizes. Write for fully descriptive data sheet.

OCECO TANK FITTINGS

THE JOHNSTON & JENNINGS CO.
division of PETTIBONE MULLIKEN CORP.
4751 West Division St. • Chicago 51, Illinois

The PELICAN

THE *Lowest* PRICED TWO-INCH PUMP OF ITS CAPACITY ON THE MARKET

Gorman-Rupp self-priming centrifugal pumps are especially designed to meet the toughest requirements. The Pelican has many useful applications around a lease and -- it challenges any pump its size and type to equal its performance -- it never quits.

Gorman-Rupp pumps are the **Quickest Priming, Highest, Priming, Fastest Pumping** and **Most Reliable** pumps available.

There's a choice of five lightweights for any requirements:

The Midget 1½"	Weight 63 lbs.	5,850 G.P.H.
The Pelican 2"	Alum. 70, C.I. 80 lbs.	8,000 G.P.H.
The Pelican 1½"	Alum. 70, C.I. 80 lbs.	6,700 G.P.H.
The Hawk 2"	Weight 110 lbs.	11,000 G.P.H.
The Eagle 3"	Weight 117 lbs.	18,000 G.P.H.

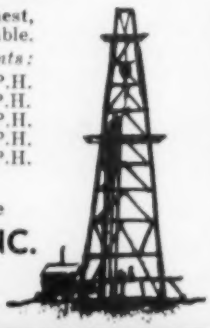
Ask for Bulletin No. 7-LW-13 Rev.

Mid-Continent and Gulf Coast Oilfield Representative

HENRY H. PARIS DISTRIBUTOR, INC.

1125 Rothwell Street, Houston, Texas

A COMPLETE LINE OF CENTRIFUGALS IS AVAILABLE UP TO 240,000 G.P.H. CAPACITY.



THE GORMAN-RUPP COMPANY
MANSFIELD, OHIO

Edward F. Kelly, formerly Dowell district area manager for West Texas, has succeeded Ramsey as district manager.

Varel Establishes Factory Branch at Odessa, Tex.

C. HANKS

A factory branch to retip and rebuild Varel rock and blade bits, has been established in Odessa, it has been announced by Daniel W. Varel, president of Varel Mfg. Co., Dallas.

Factory methods and factory-trained mechanics are under the direction of F. A. (Red) Neville, shop superintendent, who has had over 6 years' experience in the Varel plant in Dallas, where rock bits and blade bits are manufactured.

To assure original bit quality, new acetylene-welding equipment and generators, as well as newest atomic-hydrogen welders have been installed, according to Charlie Hanks, Odessa branch manager.

Williams Named to Helicoid Sales in Dallas-Tulsa Area

J. H. WILLIAMS

Joe H. Williams has been appointed sales representative for Helicoid Gage Division, American Chain & Cable Co., in the Dallas-Tulsa area, according to an announcement by V. E. Lysaght, division sales manager at Bridgeport, Conn.

Williams, who will make his headquarters in Dallas, will cover the northern parts of Texas and Louisiana, and all of Oklahoma. Helicoid Gage Division manufactures a complete line of pressure gages.

Prior to joining American Chain & Cable in February 1954, Williams was employed by Stone & Webster Engineering Corp., The Lummis Co., and Bowen Co. of Texas, Inc.

Walex Names Tracey As General Sales Manager

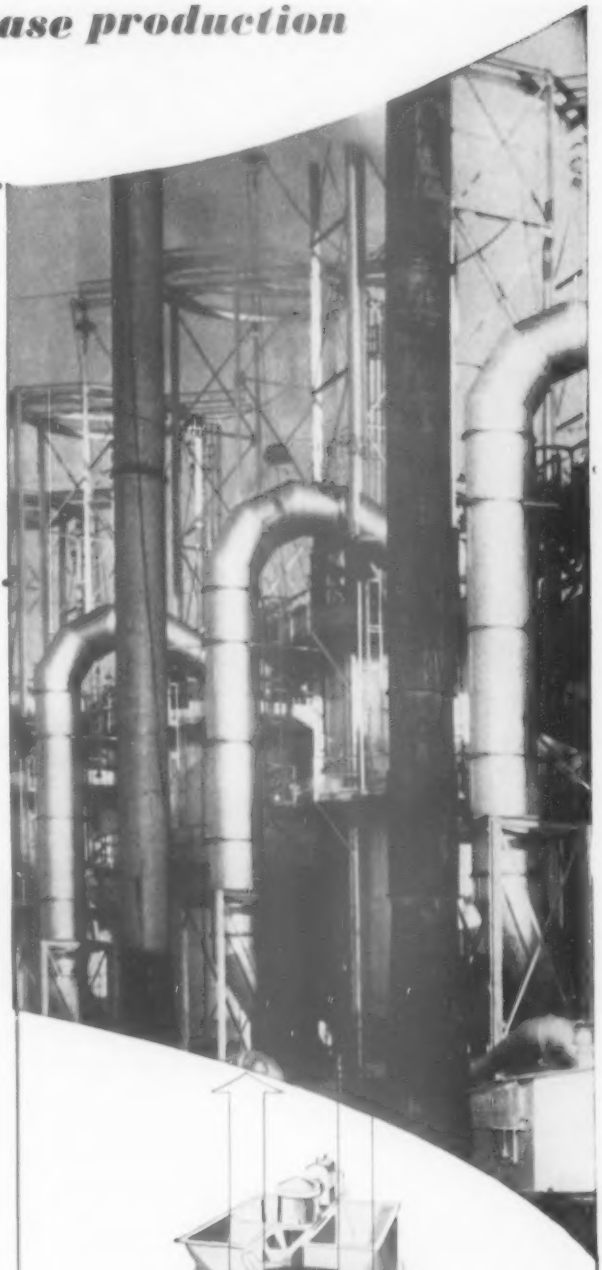
Ed Tracey has been named general sales manager of Walex Metal Products Co., Walter Alexander, president, has announced.

Before coming to Walex Metal Prod-

Reduce slag . . . increase production

with the

Ljungstrom Air Preheater



Slag – primary cause of reduced capacity – can be practically eliminated by the use of a Ljungstrom Air Preheater.

That's because preheated air mixes more thoroughly with the fuel. Therefore, less excess air is required for complete combustion – and less combustible material is lost in the flue gases.

Thus, with a Ljungstrom Air Preheater, there is less material present in the furnace for slag production. Oil tubes stay cleaner . . . longer. Stills stay on stream *at top production* for months longer.

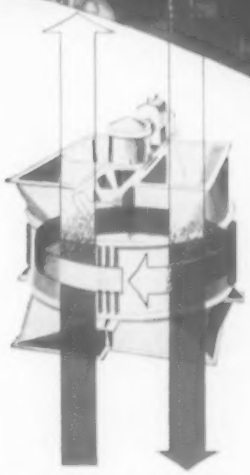
For example, a pipe still in an eastern refinery dropped from 16,000 barrels a day to 12,000 because of slag. Now, with a Ljungstrom Air Preheater and modern high-temperature burners, the still operates *continuously at 18,000/20,000 barrels.*

This saving alone can pay for a Ljungstrom installation in less than a year. Add it to more economical furnace design possible . . . up to 20% fuel savings . . . greater heat recovery even from low grade fuels . . . higher through-put – and you can see why the Ljungstrom Air Preheater is perhaps *the most significant guidepost to economy available today to refiners.*

For more complete details on what the Ljungstrom Air Preheater can do for you . . . for an analysis of the heat recovery benefits attainable in your fuel burning equipment – call or write The Air Preheater Corporation today.

The Air Preheater Corporation

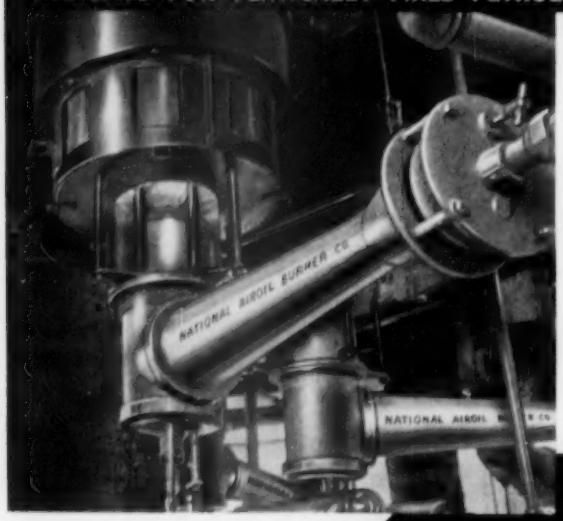
60 East 42nd Street, New York 17, N. Y.

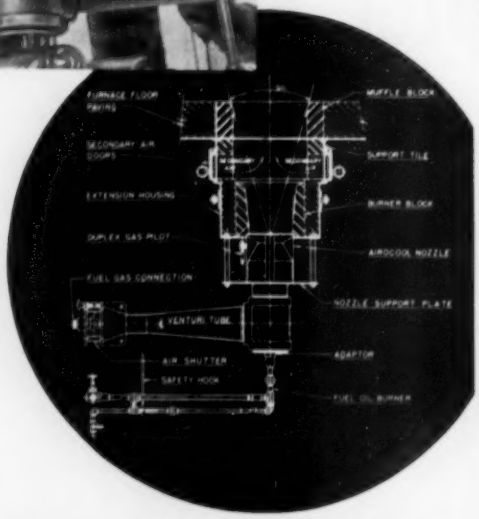


The Ljungstrom operates on the continuous regenerative counter-flow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves, the heat is transferred from the waste gases to the incoming cold air.

WHEREVER YOU BURN FUEL, YOU NEED LJUNGSTROM

DESIGNED FOR VERTICALLY FIRED PETROLEUM HEATERS





NATIONAL AIROIL

VERTICAL

Oil-Gas Tandem Combustion Units

many more hours on stream, without forced shutdown

Exclusively for vertical firing, National Airoil VERTICAL C-P Tandem Block Units retain all the features of our regular well-known Tandem Units . . . plus: special pre-cast refractory shapes for easier installation and maintenance; secondary air louvres for positive control of flame pattern; and an all steel duplex detaching gear which enables swift, easy, oil burner removal.

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Buckeye Opens New Sales Office At Wichita, Kans.

M. H. KENNEDY

Buckeye Supply Co. has announced the opening of a district sales office at Wichita. The new office will be under the supervision of Max. H. Kennedy, who has recently been appointed district manager for Kansas. M. W. McClure has been appointed city salesman of Buckeye's new Wichita office.

E. G. Sweeney, former Kansas district manager for Buckeye, has been

M. W. McCLURE

E. G. SWEENEY

transferred to Denver and will open and manage a sales office for Buckeye there.

Kennedy was formerly employed by Continental Supply Co. from 1926 until 1944, serving in Coffeyville, Russell, and El Dorado, Kans. He worked 1 year in Parkersburg Rig & Reel Co.'s sales department at Coffeyville, and then reentered the employ of Continental as manager of the Casper, Wyo., store. In 1947 he was employed by Oil Well Supply Co. as manager of the El Dorado store, remained there until 1950, and then joined Buckeye as store manager of their El Dorado branch.

McClure, prior to joining Buckeye in May 1954, was associated with Bridgeport Machine Co. for 18 years, Continental Supply Co. for 8 years, and H. M. Williams Drilling Co. for 2½ years.

Sweeney has formerly been associated with Bridgeport Machine Co., H. B. Walker Co., and Altens Foundry & Machine Co. He started with Buckeye as purchasing agent in 1944 and served in this capacity until 1952, at which time he was transferred to El Dorado to serve as district manager.

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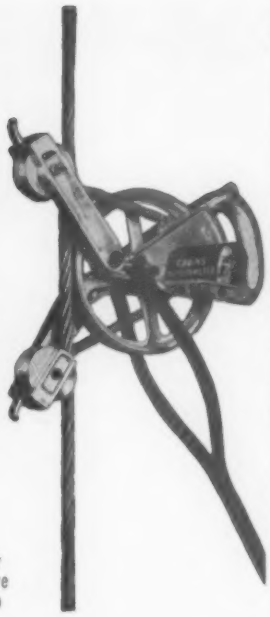

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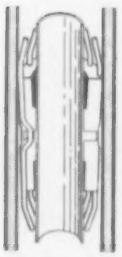

Sketch showing principle of Bell Reversible Cups. Upper end is expanded to contact tubing wall and carry load. Lower end is contracted by bowl on swab. Note sturdy guide wires and rugged construction of cup. Compressibility of cup lets swab fall easily. With two ends to use, each Bell Reversible Cup does more work than an ordinary cup. Long-wearing materials provide the utmost economy in expenditure for swabbing operations.

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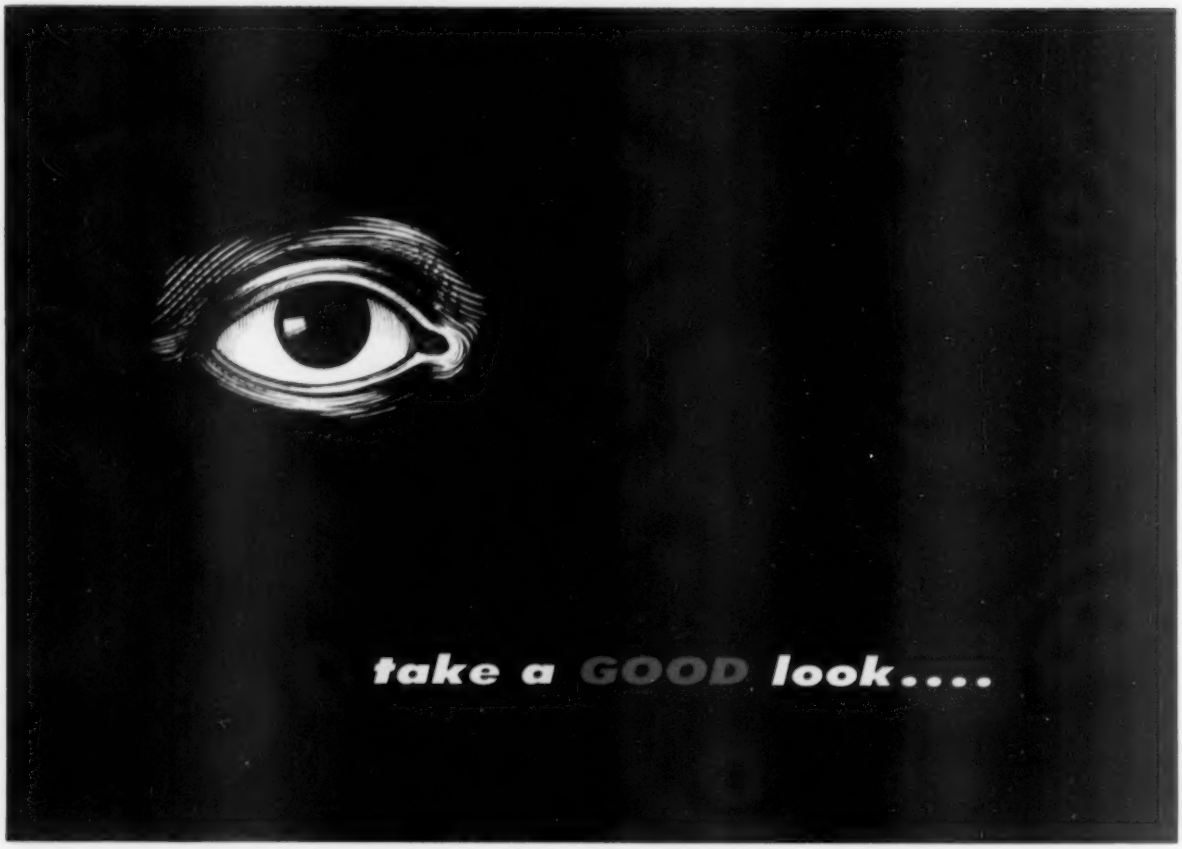

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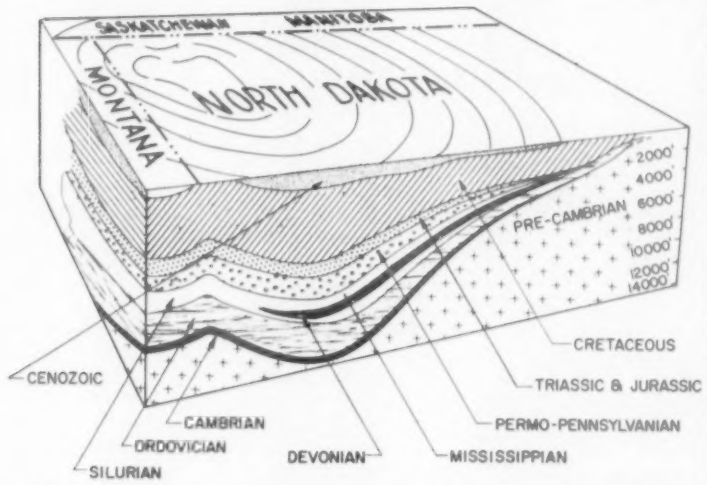

This 3-D sketch shows the subsurface conditions now believed to exist on Williston basin's east flank. The search for wedge traps is in full swing at present.

Configuration of Williston's basement rocks on the east side is shown in this contour map (after Kornfeld).

Whither Williston?

by Frank J. Gardner

DISCOVERY of oil in the Williston basin in January 1951 set off one of the great oil booms of our time. A single pint of oil recovered on a test in Amerada Petroleum Corp. 1 Iverson electrified the industry and launched an unprecedented amount of activity. In terms of acreage involved, it was the greatest lease play in history, with some 30 million acres leased during the first year of excitement. Geologists, operators, map makers, leasehounds, and news services swarmed into North Dakota and whipped up exploratory whirlwinds unlike anything since East Texas.

A great target . . . Here was the biggest oil basin yet laid before the U. S. oil man; it covered an area of 118,500 sq. miles and offered nearly 76 million acres of hunting ground for new fields. A sedimentary column varying in thickness from 2,000 ft. in Manitoba to more than 12,000 ft. at the basin center offered multiple-pay prospects unrivaled by any other area.

But as things developed, the Williston province presented difficulties as well as enticements; weather extremes, difficult transportation problems, housing shortages, and half-million-dollar wells tended to label the basin as a "big-money" operation. Independents shied away from the deeper parts and looked eastward and southward to the basin flanks as the best base of operations for them.

So the whirlwinds died down. After the first deep fields came in and development got under way, Williston took a good look at itself and settled down for serious exploratory programs. Results have not been spectacular. Few fields have been found off the larger structures like the Nesson and Baker-Glendive anticlines.

At a threshold . . . What, then, lies ahead for this vast basin? Its status is not unlike that of the smaller Permian basin in the late 1920's. Geologists simply have not yet solved the riddle of its secrets. Exploration men have not crossed it off as a lost cause; drilling is still going on at a rapid pace. But there has been a shift of emphasis. The independent operator, the dynamo of discovery, has begun in earnest the search for the stratigraphic wedge traps that everyone believes must surely exist on the eastern flank of the basin.

He hasn't had much success. But he will. It's happened in Manitoba, and it will happen here. During the current year and most of last year, east-side drilling formed the bulk of the basin's activity in terms of number of holes drilled. It is this shallow flank prospecting that holds the key to the growth of Williston as a major oil province. When discovery occurs, many exploration men believe that North Dakota's east-side area will undergo an accelerated campaign similar to the Denver-Julesburg drilling spree in northeastern Colorado.

Geological conditions portrayed in the 3-D sketch on this page are textbook strat-trap geology. The only way to find the wedge reservoirs that are believed almost certain to exist is to drill. The seismograph can pick them out to a certain extent, but 500 ft. of glacial drift on the surface presents a difficult obstacle. The answer, then, is to probe for pools. A look at the east-side drilling record since 1950 reveals a phenomenal upsurge of activity:

1950: 2 tests
1951: 10 tests
1952: 26 tests
1953: 71 tests
1954: 67 tests

Expecting discovery . . . Of the holes completed so far, many have reported showings in samples or cores, but insufficient showings to hold promise of a well. They do indicate, however, that eventually the fields will be found. The discoveries in southwestern Manitoba (Roselea, Virden, and others) provide the encouragement, the showings provide the stimulus, and multiple drilling (largely slim-hole) will provide the discovery.

The play is not limited to independent operators, for the major companies too are actively in the search; but farmouts are becoming more and more numerous and easier to find, and this was a tremendous factor in the original development of the Denver-Julesburg basin. It could happen here.

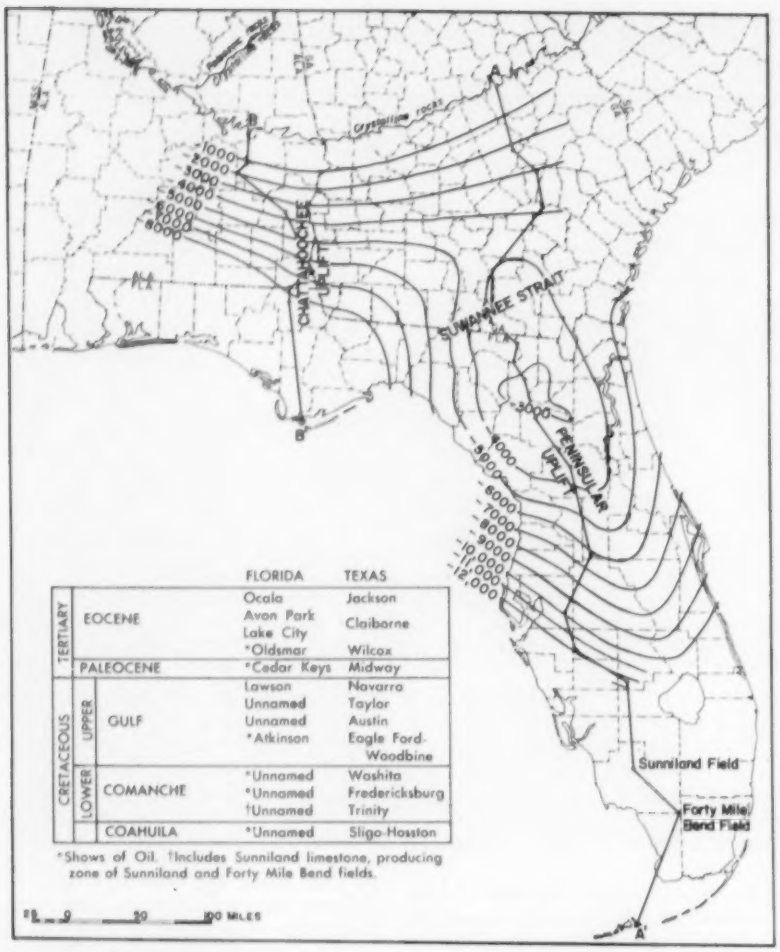

Fig. 1—Central and Southern Florida is rank wildcat country where potential reservoirs and structures are considered to exist.

A critical appraisal of

Oil Possibilities in Florida

Peninsular area can be considered virgin territory

by Louise Jordan

WELLS in Florida have logged shows of oil in rocks of lower Eocene, Paleocene, Upper and Lower Cretaceous age at depths ranging from 2,600 to 13,000 ft. Structural and stratigraphic traps including reefs in which oil can accumulate are present and will be found under an intensive geophysical and drilling program.

Only 30 deep wildcats which can be considered adequate tests have been drilled in the 23½ million acres of central and south Florida, which should still be considered a virgin territory in drilling and exploration.

Author is a geological consultant, Tallahasse.

Geology

Coastal-plain sediments formed in the Gulf of Mexico geosyncline in peninsula Florida range in age from Jurassic to Recent. The floor on which these sediments rest was a peneplained surface formed before the deposition of Jurassic rocks. (See Applin, 1951). The configuration of this subcrop or floor of pre-Jurassic rocks at its present position is shown in Fig. 1.

Fig. 2 shows two cross-sections, A-A′ from the igneous rocks of the piedmont in Georgia across the Peninsular uplift to Big Pine Key in the Florida Keys, and B-B′ from the crystalline rocks in Alabama across the Chattahooche uplift* south of the Gulf of Mexico near the mouth of the Appalachicola River.

Structure . . . The major structural feature of peninsular Florida is the Peninsular arch or uplift, which has been an active and positive area since the beginning of the Gulf of Mexico geosyncline in Jurassic time. (Fig. 1.) It projects southward and forms the backbone of the Florida peninsula. The highest portion of the uplift as presently known is to be found in East Central Columbia County, Florida, where a well penetrated early Paleozoic sediments at a depth of 2,640 ft. below sea level.

The Chattahoochee uplift, a minor structural feature along the Appalachicola and Chattahoochee rivers, is likewise an area in which Paleozoic sediments are encountered below red beds of probable Jurassic age. Movement since pre-Jurassic time has not been as extensive as in the area of Peninsular uplift, but has resulted in a slight thinning of beds of Paleocene to Eocene, upper and Lower Cretaceous (Figs. 3-4).

The pre-Jurassic floor between these two uplifts is made up of Trassic sedimentry rocks and igneous intrusions. It is reasonable to postulate that the upward movement of these two structural features has been along fault zones which were present in the truncated floor on which the coastal-plain sediments deposited. The subcrop of Paleozoic and igneous rocks of the Peninsular uplift also indicate block faulting. (See Bridge and Berdan, 1951).

The Suwanee strait, a prominent erosional feaure in the subsurface (Fig. 1) extending southwesterly across southern Georgia and into Florida between the Peninsular and Chattahoochee uplifts, is the result of regional movement at the end of Cretaceous time which caused a channel to be cut along a line between predominately clastic rocks of Georgia and carbonates of Florida (Fig. 2, A-A′ just north of Florida boundary).

Stratigraphy

Rocks of Pleistocene, Pliocene, and

*This uplift has been called Decatur, Marianna-Chipley, and Marietta by various authors, but was named Chatahoochee at least as early as 1911 by Veatch and Stephenson. Again in 1928, Stephenson clearly indicated it as the Chattachoochee upwarp.

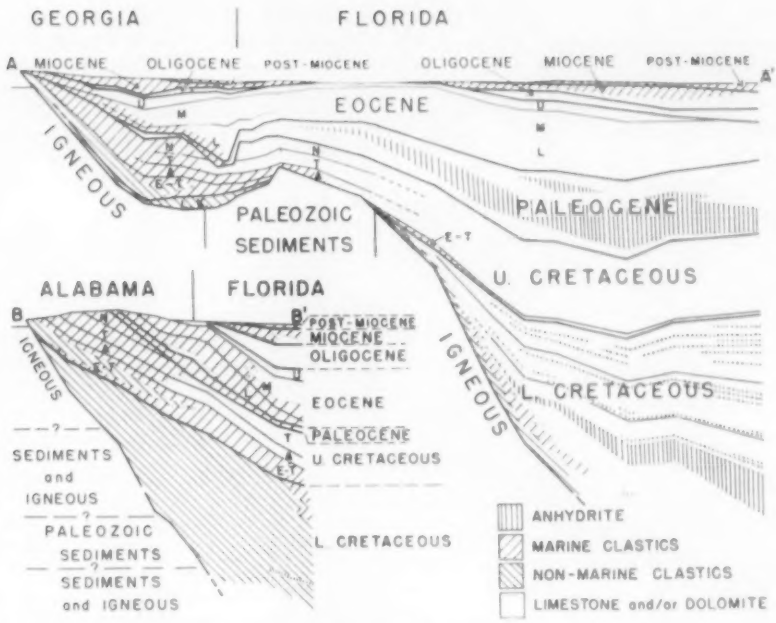

Fig. 2—Cross-section A-A′ shows the pinching out of the Lower Cretaceous sediments against the Peninsular uplift. These sediments are present both north and west of the uplift as shown by B-B′.

Oligocene series do not reach a thickness of more than 1,400 ft. in peninsular Florida and in some areas are entirely missing. Except for Pleistocene stream and terrack deposits, these series are essentially marine clastics and carbonates. Chart 1 tabulates the formational names in Florida with their Texas equivalents (Fig. 1).

Eocene series . . . The Eocene series is divided into several formations as shown on Chart 1. In parts of Central and North Florida, Ocala and Avon Park limestones outcrop or are below a thin layer of carbonate and clastic sediments. All of the rocks of the Eocene series consist essentially of coquinoid limestones, which may or may not be dolomitized, may have good primary or secondary porosity, and are interbedded with dense chalk, dolomite or limestone. Not a great deal is known about the stratigraphy and oil shows of these formations as this interval has been drilled blind in the majority of tests drilled for oil. However, shows of oil have been found in South Florida in the Oldsmar limestone at depths between 2,500 and 2,800 ft.

Paleocene series . . . The Paleocene series, represented by the Cedar Keys formation, consists of coquinoid porous to nonporous limestone and dolomite and anhydrite. The formation thickens from approximately 300 ft. in North Florida to over 2,000 ft. in South Florida where over 50 per cent of the formation is anhydrite.

Oil shows have been found in several zones of the Cedar Keys formation, both near the top and bottom of the formation in porous coquinoid limestone or dolomite overlain by anhydrite. Several drill-stem tests have been made in the lower-oil-show zone resulting in a film of oil and salt water, but it has not been tested on a structural high.

Isopachous maps of the Eocene-

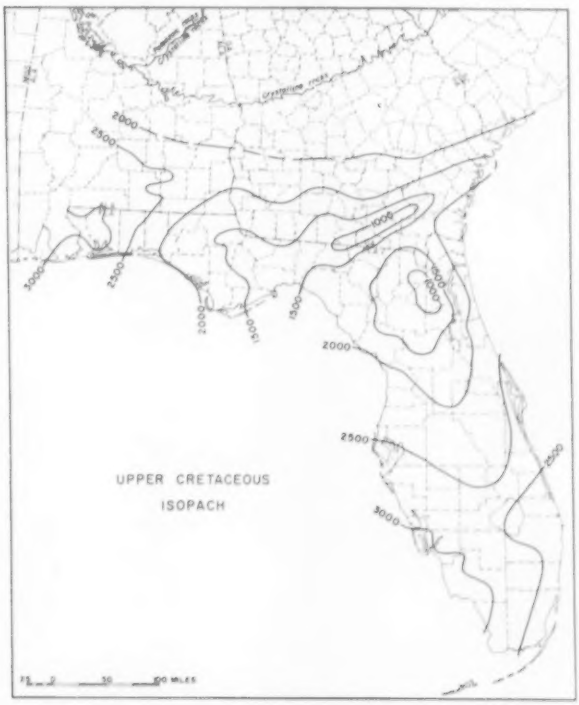

Fig. 3—Upper Cretaceous sediments thicken to the south in Florida; these beds are only about 1,000 ft. thick over the Peninsular uplift, indicating that it was a positive area at that time.

Fig. 4—Lower Cretaceous rocks are missing over a large area in northern Florida. In the Florida Keys, one well penetrated nearly 8,000 ft. of Lower Cretaceous and never reached the basal sands.

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Paleocene interval show a basin of sedimentation in South Florida during this time. Most of the subsidence of this basin took place during the time of deposition of the Oldsmar limestone and Cedar Keys formation. Sediments of the Eocene-Paleocene series reach a thickness of at least 2,450 ft. in the Suwannee strait.

Upper Cretaceous, Gulf series . . . The Lawson limestone is composed of chalk, anhydritic dolomite, chalky and argillaceous limestone and dolomite, and porous micro and macrocoquinoid limestone and dolomite. In some areas in South Florida, porous to cavernous rudistid macrofossiliferous limestones over 100 ft. thick have had shows of oil at depths averaging about 5,000 ft.

Beds of Taylor age are essentially chalk, while those of Austin age are interlaminated chalk and calcareous shale except that, over the Peninsula uplift an Austin sand is found above the Atkinson formation or resting directly on Early Paleozoic rocks. No shows of oil have been noted in these rocks, but basal Austin shales frequently have a petroliferous odor.

The Atkinson formation in North Florida is a marine sand and shale series which surrounds and pinches out on the Peninsula uplift. In this area some 50 wildcat wells have been drilled on 9 million acres of land, and no shows were found. Although the absence of oil shows in these wells has been discouraging, one well to 180,000 acres has not adequately tested the area. On the southern flank of the uplift in Central Florida, the Atkinson formation consists of marine sand, shale, oolitic and fossiliferous limestone in which a show of oil was found in one well. In this area of 6 million acres only five wells have been drilled to this formation and the underlying Lower Cretaceous carbonate section.

The isopachous map of the Upper Cretaceous, Fig. 3, shows one thin area of rocks over the Peninsular uplift where the early Upper Cretaceous rocks are missing, and another in the Suwanne strait where late Upper Cretaceous strata have been eroded. In Fig. 2, the wedging out of the Atkinson formation (indicated by "E-T") both north and south of the Peninsular uplift is clearly shown.

Lower Cretaceous, Comanche series . . . Surrounding the Peninsular uplift, Lower Cretaceous rocks are varigated claystones, red and gray sandstones, and conglomerates, and are missing over a large area shown on isopacheous map, Fig. 4. On the southern flank of the uplift, a marine section of limestones and dolomites, chalk, anhydrite, and shale rests upon basal variegated clays and sands, and conglomerates,

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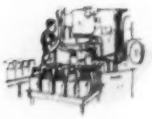

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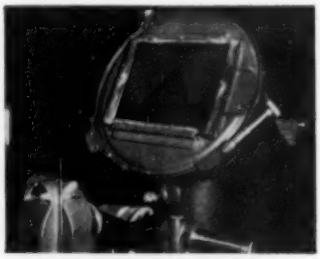

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where wells have penetrated a basement of extrusive or intrusive igneous rocks. In South Florida, south of Highland County, neither this basement nor the basal sands have been reached although nearly 8,000 ft. of Lower Cretaceous rocks was penetrated in Big Pine Key in the Florida Keys.

In Fig. 2, lines have been drawn to separate beds of Washita Fredericksburg and Trinity age. The Sunniland limestone, which is the producing zone in both Sunniland and Forty Mile Bend fields, occurs just above the thick anhydrite bed in the Trinity, which is equivalent to some part of the Glenrose formation of Texas. Porous limestones and dolomites with impermeable overlying limestone, shale, or anhydrite occur all through the section of Lower Cretaceous rocks. Dark gray calcareous shales and argillaceous limestones are quite common in the Trinity and older rocks, and a few wells have contained glauconitic sands in this interval.

Underlying the beds of Trinity age, shale, oolitic limestone, dense and porous limestone, and dolomite and anhydrite are found in which shows of oil have been noted. These rocks may be Jurassic in age or were laid down at the same time as the Sligo and Hosston formations of Louisiana (Coahuila series). At least five or six wells have so far penetrated this section.

It should be noted on A-A′ cross-section, Fig. 2, that units of Lower Cretaceous thin northward toward the Peninsular uplift. Lower Cretaceous rocks have been truncated and overlapped by Upper Cretaceous strata on the southern flank of the Peninsular uplift. The chemical character of the rocks progressively changes northward into red shales and sandstones in the basal beds which transgress upon the igneous floor.

Oil shows have been persistently found in Fredericksburg limestones which in Central Florida are reached at approximately 5,600 to 5,800 ft. and in the area of Sunniland field at 9,800 ft. Other shows of oil have also been found in beds of Fredericksburg age. Both above and below the Sunniland limestone in beds of Trinity age and older, porous limestone and dolomite have had shows of oil that have occasionally been tested.

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KANSAS

Barber County Gets New Viola Discovery

A Viola discovery is reported 1½ miles north of the Oklahoma line in Barber County, southern Kansas.

The pool opener is Aurora Gasoline and Berwick Drilling Co. 1 Gudeman, NW NW NE 10-36s-10w. Recovery on a drill-stem test at 5,158-70 ft. was 600 ft. of clean oil and 180 ft. of muddy oil.

Kingman County . . . A new oil pool for this southern Kansas county is in evidence at Greenland Drilling Co. 1 Viney, NE NE NW 19-28s-5w, 1½ miles west of Broadway field.

Several drill-stem tests in the Mississippian have shown good results.

Pawnee County strike . . . R. W. Rine Drilling Co. 1 Lovett is a new producer in this Central Kansas uplift area. The wildcat, located in NW NW NW 35-22s-15w, pumped 50 bbl. of oil per day. It is 1 mile southeast of Dunes field in southeastern Pawnee.

Graham County gets one . . . A rank wildcat in Graham County recovered 1,610 ft. of gas, 1,150 ft. of oil on drill-stem test in the Lansing at 3,890-3,930 ft.

It is Empire Drilling Co.'s 1 Keith, SW SW SW 3-9s-24w. It is 5¼ miles southeast of the town of Morland, Kansas.

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OKLAHOMA

Unconformity Zone Being Tested at Cleveland Spot

The unconformity zone is being tested at Gulf Oil Corp. 2 Wilson in NW SW NE 27-10n-1e, Cleveland County.

The well found the zone at 5,695 ft., getting stain and odor in core.

Logan County . . . The Misener sand has been perforated at J. M. Shields 1-A State in NE NE SE 36-16n-1e, Logan County.

The well flowed 7,120 M.c.f. of gas per day through ½-in. choke.

Grady County Report

Two wells in Grady County areas are taking completion tests. Magnolia 2 Burkes, C NW SW 12-4n-5w, in Southeast Bradley field, flowed 160 bbl. of oil in 11 hours through 18/64-in. choke from Springer sand at 9,356-9,476 ft.

In Chickasha field Magnolia 16 Smith flowed 72 bbl. of oil in 17 hours through 14/64-in choke in the Noble-Olson zone.

More Bromide Found at Marshall County Wildcat

The lower part of the third Bromide sand at Sinclair Oil & Gas Co. et al's 1 Griffin in Marshall County, southern Oklahoma Ardmore basin wildcat, has been tested.

The wildcat flowed 2,930 M.c.f. of gas per day from the third Bromide at 6,107-17 ft. Distillate was recovered, also. The upper portion of the third Bromide at 6,047-97 ft. also got 3,020 M.c.f. of wet gas. This is one of the most important discoveries in recent years in southern Oklahoma.

Garvin County Gets Bromide Sand Discovery

A Bromide sand reservoir has been established near Maysville in Garvin County, southern Oklahoma.

Stanolind Oil & Gas Co. 1 Pitchlynn, SE SW SE 14-4n-2w, found sand at 5,680 ft. and dug into it to 5,981 ft. Oil flowed in 30 minutes at the estimated rate of 12 bbl. hourly on drill-stem test at 5,844-5,981 ft. This discovery is on a seismic prospect investigaged during the 40's and controls were supplemented earlier this year. Stanolind's investigation recently was in the northeastern part of the township. It exhibited close interval controls in a favorable area.

Other southern work . . . Gulf Oil Corp. is near critical depth at a field deep try in Northwest Lindsay, McClain County. The 1 Smith, SW SE 17-5n-4w, found the Bromide dense at 10,840 ft. and is digging at 11,010 ft. to correlate a bit lower than nearby production.

A dual-pay well has been completed in Hoover, Garvin County, by W. A. Delaney, Jr. and Zephyr Drilling Co. The 2 Randolph, NE SE SW 11-1n-1w, flowed 59 bbl. of oil in 4 hours through ¼-in. tubing choke from the third Huber sand at 3,624-38 ft. It flowed 36 bbl. of oil in 12 hours through ½-in. choke from perforations at 3,375-90 ft. in the third Tuley sand.

Purdy district . . . Springer sand pay has been proved at Superior Oil Co. 1 Wertz Unit in C NE NE 35-4n-4w, Garvin County. The well is a joint test with Southern Production.

The well flowed through open hole at 8,678-81 ft. 12 bbl. of oil in 75 minutes through ½-in. choke. It made 8½ bbl. in 14 hours through ¼-in. choke. Operators are coring more sand.

Link well shows . . . A link well between South Panther Creek and North Foster pools in Garvin County has indicated gas-distillate pay in the upper Hart sand.

Magnolia Petroleum Co. 1 Harrison-McGee, C SW SW 12-2n-3w, drill-stem tested at 7,595 to 7,615 ft.

HUGOTON EMBAYMENT

Delaware Basin Wildcat Completed Successfully

In Hutchinson County Phillips Petroleum Co. 1 Ivy "A," 10 miles south of Hansford, continued to test as a Marmaton gas discovery and Douglas sand confirmation for North Hutchinson Penn field, 1 mile southeast.

The third test for new Kerrick Cisco lime field in northwestern Dallam County has been staked. It is Sun Oil Co. 1 Taylor, Humble 1 Kerrick Gas Unit recently opened the field and the first production in the county. Production was from the Cisco, 8,500 M.c.f. of gas per day.

Humble is running casing at a Gruver field outpost well in Hansford County. The 1 Gruver Gas Unit 7 is 1½ miles from Gruver field and also the Fulton 1 Matthews discovery.

Sharples Oil Corp. 1 Henderson, 6 miles northeast of Gruver and separated by 2 miles from Gruver Penn field by a Mississippian dry hole, is testing. The well flowed 4,000 M.c.f. of gas per day and 6 bbl. of distillate per million from the Cherokee.

Potential Taken At New Beaver County Discovery

An important Mississippian gas discovery in Beaver County, Oklahoma Panhandle, has taken potential.

The significant strike is United Producing Co.'s 1 Evans, NE SW 8-5n-25eCM. It is ½ mile north of Mocane, Okla. It had a calculated open flow of 20,200 M.c.f. of gas per day from Mississippian-Chester perforations at 6,894-6,924 ft. The wildcat also had Morrow-Pennsylvanian prospects, but no production tests were taken in that zone. The discovery is 5 miles northeast of Southwest Mocane field.

The Kansas Nomenclature Committee has designated J. M. Huber Corp.'s 1 Sparks in C NE 34-30s-42w, 8 miles south of Manter and 10 miles west of Permian production in Hugoton field, as Sparks field. The discovery flowed 15,600 M.c.f. of gas per day from Keyes (basal Morrow-Pennsylvanian) perforations at 5,254-75 ft. The pool opener has been shut in for several months.

Eva area . . . United Carbon Co. 1 Burns, SW SE 10-4n-10eCM, 1-mile southwest extension to oil production in Northwest Eva field, Texas County, Oklahoma, pumped 83 bbl. of oil per day from Kelly (basal Morrow-Penn) sand perforations at 4,456-64 ft. A north offset is drilling at 4,600 ft. at 2 Burns, NW SE 10.

Beaver County field . . . United is testing a 1½-mile southwest extension to Texas Co.'s 1 Barby "A," discovery well of Southeast Mocane field. The 1 Loyd Barby, SW NE 10-4n-25eCM, flowed 1,000 M.c.f. of gas per day from Morrow sand perforations at 6,840-60 ft.

Rank wildcat . . . Garr-Woolley 1 Laws, NE SE 21-3n-22eCM, Beaver County, is a rank test 11 miles south of Floris field.

The remote well reported shows in the Marmaton-Pennsylvanian at 5,822-50 ft.

APPALACHIAN AREA

OHIO

A discovery was reported by Clyde Foraker, Jr. et al north of Glenford in Hopewell Township, Perry County, on their 1 L. Forbet, Section 4. Clinton sand at 2,816-38 ft. made 15 bbl. natural and 92 bbl. oil with 300,000 cu. ft. gas in a 24-hour test after fracturing.

In New Castle Township, Coshocton County, the Pure Oil 2 David Busenburg, 3rd. Qr., the second well to be completed in a step-out pool, made 340 bbl. in 15 hours after fracturing. Clinton was found at 3,112-60 ft. with 800 ft. oil in 10 hours natural.

Oxford Oil 3 N. O. Crown, 3rd Qr., Licking Township, Muskingum County, a short east extension, logged the Clinton at 3,126-70 ft. with a fair showing natural and 460 bbl. in 24 hours after fracturing.

PENNSYLVANIA

In Unity Township, Westmoreland County, Southwest Pennsylvania, Peoples Natural Gas Co. 1-4017 J. A. Mills, wildcat was dry, Chert 8,038 ft., TD 8,255 ft. Parker Township, Butler County, Walker et al 1 John Walker, is drilling at 7,040 ft. Banks Township, Indiana County, Keta Oil & Gas Co. et al 1802 Farmers & Miners Trust Co., lost the bit at 6,700 ft., and in Grant Township, Fairman Drilling Co. 1 Herb Gernandt, is drilling at 7,576 ft.

WEST VIRGINIA

Middle Fork district, Randolph County, West Virginia, Washington Natural Gas Co. 3-5 E. S. Newlon heirs wildcat was small, gaging only 73,000 cu. ft. of gas in the Fifth sand after sandfrac. TD 2,521 ft.

KENTUCKY

EASTERN KENTUCKY

In Estill County, 3-O-69, Buffalo Oil Co. has a dry hole at their 9 George Reed heirs. At an elevation of 711 ft. Corniferous limestone was topped at 876 ft. with no shows. Hole was bottomed at 975 ft.

In Leslie County, United Fuel Gas Co. 7

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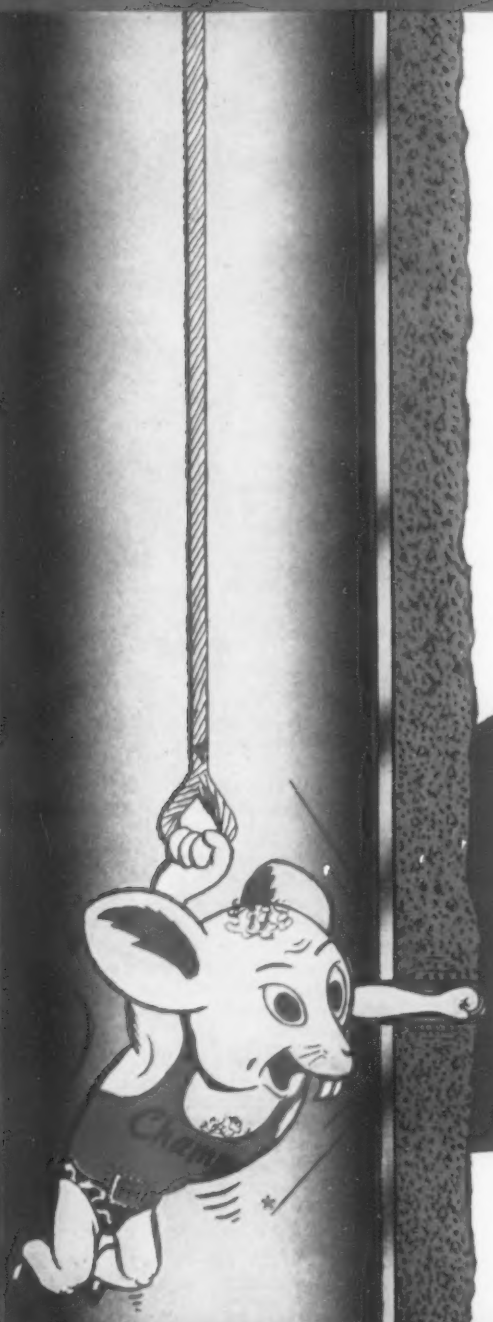

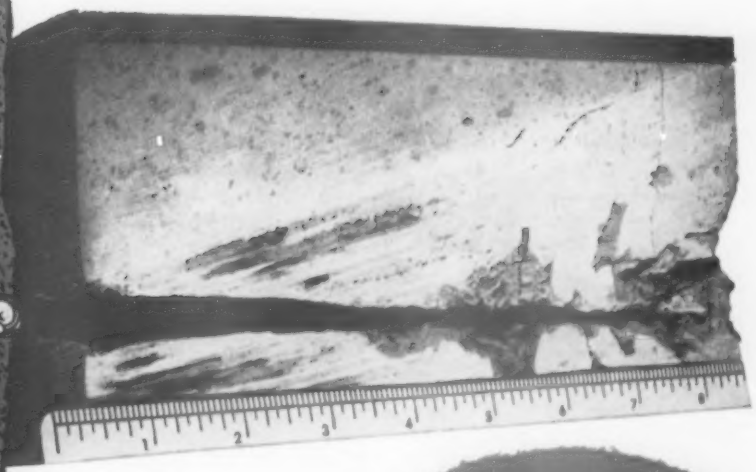

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Fordson Coal Co., a wildcat on Elisha Creek had Mississippian Big lime from 1,822 to 2,074 ft. Injun sand from 2,074-2,095 ft. and topped Corniferous lime at 2,599 ft. A gas flow of 66,000 cu. ft. daily was had from 2,600-2,604 and oil estimated at 3 bbl. daily from 2,626-2,630 ft. Operator is currently fishing for tools at a total depth of 2,699 ft.

MICHIGAN

Production tests were in progress this week at the William J. Morriss 1 Downing, NW NW SE 1-6s-5e, Ridgeway Township wildcat, Lenawee County, after a small natural oil showing in the Trenton was acidized with 2,000 gal. Well was rated good for about 25 bbl. of oil and a like amount of water a day, on swab-test, after the acidization. Top of Trenton was logged at 2,408 ft. and hole was drilled to 2,491 ft., total depth. About 100,000 cu. ft. of gas a day showed natural in the top of the Trenton. At 2,490-91 ft., hole carried 5 gal. of free oil natural in 20 hours, which was shot with 120 qt. of nitro without successful results. Another possible Trenton pay was logged at about 2,415-25 ft. Operator may plug off the acidized and shot section and reacidize this upper pay. Well swabbed back entire acidizing fluids, plus 60 bbl. of net oil first day after treatment, and on the following day, still being swabbed through 5-in. casing, well showed for 25 bbl. of oil, plus water in 4 hours.

This wildcat is located approximately 3 miles due north of Deerfield oil pool, Monroe County, Michigan's first Trenton oil field.

An outpost located about 3 miles northwest of Northville Trenton gas and oil pool, Washtenaw County, logged a show of gas and some free oil 758 to 774 ft. below the top of the Trenton. The E. C. Meredith and E. C. Ryder 1 Atchison & Peters, NW SE SW 21-1n-7e, Lyon Township, Oakland County, logged the small oil pay at 5,358 ft., and the gas show, which was said to blow steadily through a 2-in. bleeder, and to burn continuously, at 5,374 ft. Hole carried 1,600 ft. of water at 5,394 ft. Top of Trenton was logged at 4,600 ft. These are the deepest showings reported in the Trenton since the southeastern campaign was started. Hole was being plugged back and operators planned to acidize the gas show.

NEW MEXICO

SOUTHEAST NEW MEXICO

Continental Oil Co. 2 Bell Lake Unit, 30-20s-34e, has been completed as a Wolfcamp gas-distillate discovery. Flowing potential through 11/64-in. choke was 140 bbl. of 55.8° oil and 13,100,000 cu. ft. of gas, from perforations at 12,635-65 ft. Top of the Wolfcamp was 11,570 ft. on elevation of 3,617 ft. This well is 1 mile north of the company's first operation in the area.

Pennsylvanian prospect . . . Continental 1 West Anderson Ranch Unit, 6-16s-32e, approximately 4 miles northwest of Anderson Ranch field, showed gas and distillate on a drill-stem test in the Bend conglomerate at 12,314-12,569 ft.

Gas and water blanket flowed in 30 minutes, with maximum gas volume measured at 3,500,000 cu. ft. daily. The flow was mostly drilling mud but recovery included 450 ft. of 50° distillate and 270 ft. of heavily gas-cut mud. Bottom-hole flowing pressure reached 2,125 psi.

Production in Anderson Ranch field is from the Devonian and Wolfcamp.

TEXAS

NORTH TEXAS

Wise County Adds New Distillate Discoveries

Christie, Mitchell & Mitchell, Houston operators, have completed two new gas-distillate wells in Wise County, and a 6,000-ft. test has been slated for the area north of Keeter, by Lloyd H. Smith.

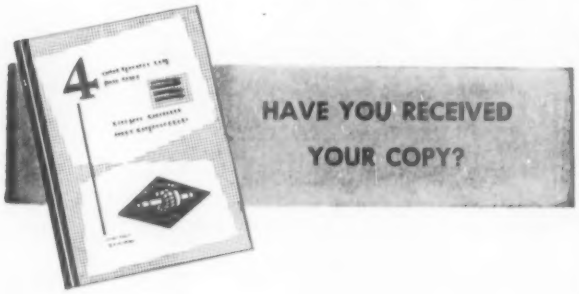
In central Wise County, Christie, Mitchell & Mitchell 1 Chandler-Davis Unit, located 6 miles southwest of Decatur and 2 miles southwest of present production, gaged 1,176,000 cu. ft. of gas a day on 16/64-in. choke, plus 12 bbl. of distillate per 1,000,000 cu. ft. of gas. Pay top was not reported. Today depth was 6,225 ft.

The same firm's 1 Deavers, in northern Wise 2 miles southeast of Alvord, completed for 1,410,000 cu. ft. of gas a day through 1/64-in. choke, plus 15 bbl. of distillate per 1,000,000 cu. ft. of gas. Flowing tubing pressure was 1,075 psi. Total depth was 5,920 ft.

The new exploration by Lloyd Smith is to be 1 R. E. Petty, located in the J. B. Pier Survey, A-691, 2 miles north of Keeter. Location is in south-central Wise County.

Nolan County . . . A Caddo lime discovery, or new pay opener for White Flat field has been potentialed by Roark-Hooker and The Chicago Corp. No. 1 B. C. Payne in 31-19-T&P Survey, completed for 153 bbl. of 48° oil a day through ¼-in. choke from perforations at 5,515-31 ft. Flowing tubing pressure was 280 psi, and gas-oil ratio was 1,385:1. Top of pay was 5,486 ft. Other production in the field is from the Ellenburger and the Cambrian.

Payne-Johnson-Byars 1 Causseaux, 4 miles



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west of Trent, has been completed as a flowing well from Caddo lime. Potential test of 8 hours was 121 bbl. of 47.8° oil, through ¼-in. choke from pay at 5,516-34 ft. Flowing pressure was 700 psi. and gas-oil ratio was 621:1. Location is in 31-19-T&P Survey.

WEST TEXAS

Discovery Prospect May Extend Ellenburger Trend

A heavy flow of oil from The Texas Co. 1 Texas-Magnolia-Sallie W. Ratliff, Ector County wildcat north of Odessa, promised to add another Ellenburger structure to the growing list of new fields in this area. Location in Section 25, Block 42, TIS, T&P Survey, is 4½ miles northwest of nearest wells in Headlee pool, and is the northernmost location along the Ellenburger "trend" of recent development northwest from Peck and Pegasus fields.

Top of the Ellenburger in 1 Ratliff was around 13,560 ft. On initial drill-stem test, at 13,560-13,585 ft. the well showed gas and recovered a good show of oil. Operators cored fractured dolomite to 13,605 ft. then tested the entire section. Gas surfaced in 37 minutes and oil in 115 minutes. According to report, the separator was too small to handle the flow and it was turned into pits where it made an estimated 100 bbl. of oil an hour.

Importance of the new strike is enhanced by its location along the trend of new and highly productive Ellenburger fields along the eastern flank of the central basin platform. Corrected total depth at 13,605 ft. was said to be around 71 ft. lower than the water table in Headlee field, indicating a separate producing structure at the new well.

Crane County strike . . . Gulf Oil Corp. 221 Waddell, Ordovician discovery west of Sand Hills field in Crane County, ran electrical surveys and prepared to complete, following a heavy flow of oil. On a late test, at 6,320-80 ft., the well flowed oil in 21 minutes, and tanked 446 bbl. of oil plus 48 bbl. of salt water in 10 hours. Bottom-hole flowing pressure reached 2,325 psi. and gas-oil ratio was 272:1.

TEXAS GULF COAST

Refugio County Wildcat Completed As Producer

Field Drilling Co., of San Antonio, is opening a new oil-field in northern Refugio County. Discovery well is its 1 James F. Welder heirs, located in the J. Power and J. Hewitson Survey, 3 miles northwest of Vidauri, and about the same distance north of Greta field. In production tests, the well flowed at the rate of 128 bbl. of oil per day through ⅛-in. choke under pressure of 1,050

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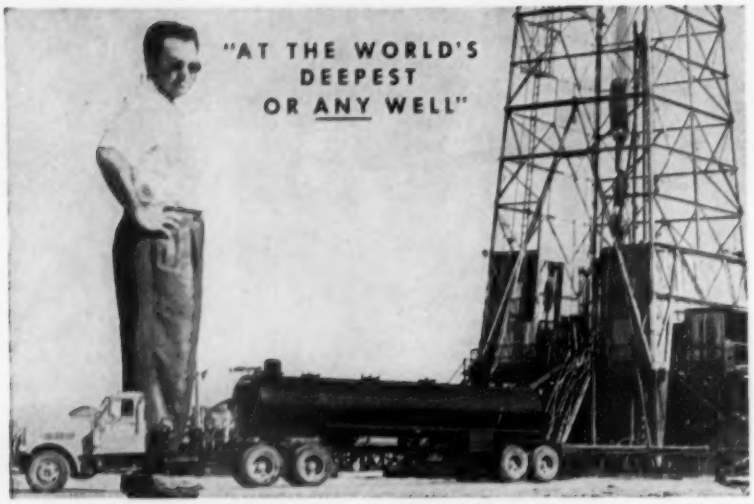

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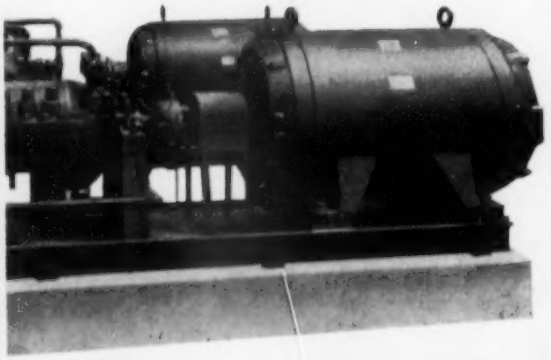

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psi. and with gas-oil ratio of 380 cu. ft. per barrel. Production is from a 5,800-ft. Frio sand.

Cecil Noble Field Gets New Dual-Pay Producer

C. N. Housh and American Republics Corp. are making another dual-zone completion in the steadily expanding, multiple-sand Cecil Noble field, adjacent the Columbus townsite, in Colorado County. At the same time, they are starting two additional deep wells, one to be directionally drilled under the bed of the Colorado River.

The well being dually completed is their 1 Isgrig. Its two productive horizons are the Schiller zone, perforated at 8,926-58 ft., and the shallower Wooten sand, perforated at 8,444-88 ft. Both zones are in the Wilcox section. From the lower sand, in which first completion was made, the well had a calculated open-flow potential of 5,000,000 cu. ft. of gas per day with a subtsantial content of 49.9°-gravity condensate. Open-flow potential of the upper sand was 3,100,000 cu. ft. of gas per day with gas-condensate ratio of 24,000 cu. ft. per barrel. Shut-in pressure gaged 2,400 psi.

New tests starting are 1 Henry Weber et al, located in Block 66, Columbus townsite, and 1 State-Colorado River. Surface location of the latter is 115 ft. west of the river bank, and 550 ft. southeast of the northeast corner of Columbus townsite. Both are projected to 12,000 ft., which will carry the hole through all the 10 presently known productive horizons of the field.

SOUTHWEST TEXAS

Another Chalk Discovery Indicated In Frio County

Discovery of another Frio County Austin-Chalk oil field, located 10 miles east of Pearsall, is indicated in drill-stem tests made by Athens & Fitzgerald, of San Antonio, at their 1 Peters. Recovery of 1,300 ft. of pipeline oil was obtained in a 60-minute test with bottom of the hole at 5,492 ft. and casing at 5,389 ft. Since that test, hole has been cored to 5,592 ft., getting additional fractured chalk, and where another test is being taken.

Second Well Drilling In New Duval County Field

Drilling is under way on the first confirmation test in the newly discovered La Juna field, 12 miles northwest of San Diego, in northeastern Duval County, near the Jim Wells County line. Location is 933 ft. southeast of the discovery well, on the same lease.

In the meantime potential tests have been taken at the discovery well, 1 Canales, drilled by J. S. Walker and A. W. Gregg Drilling Co. Gaged through 12/64-in. choke, the well flowed 118.6 bbl. of 49.4°-gravity oil in 24 hours with pressure of 640 psi. and gas-oil ratio of 1,220 cu. ft. per barrel. Producing interval is 4,715-24 ft.

Carrizo Sand Produces In New La Salle County Pool

A new Carrizo pool is being opened 15 miles southeast of Cotulla, in the west central part of La Salle County. Discovery well, drilled by Horace Coon, Jr., and C. D. Dunwoody, Jr., of Houston, is being completed on the pump, good for 89 to 90 bbl. of 38°-gravity oil per day with pay in open hole at 3,305-09 ft. The well, 2 Storey, is 950 ft. southeast of the operators' initial test, plugged a month ago.

New Producer Confirms Frio County Discovery

Drilling & Exploration Co., Inc.'s recent discovery of Austin Chalk oil-production in the Melon area, 2½ miles southwest of Pearsall, in Frio County, is being confirmed by Howeth & Mason and Texas Eastern Production Corp.

The latter operators' 1 Irma Mills, second test in the area, testing the Austin Chalk pay zone of the discovery well, swabbed 62 bbl. of water-free oil in 6 hours and is virtually assured of commercial production. Pumping equipment is being installed for completion.

The confirmation well has approximately 100 ft. of fractured chalk section, topped at 5,465 ft. Hole was drilled to 5,807 ft., and is being completed with pay section open. Pay was treated with 5,000 gal. of acid before testing.

Drilling & Exploration Co., Inc.'s discovery well, 1 Woodward, completed last August, flowed initially, making 240 bbl. of oil in 20½ hours. Later, on the pump, it produced at the rate of 4 bbl. per hour. Its pay is in open hole at 5,520-5,899 ft.

INDIANA

In Posey County Coy Oil Co., Inc. and Allied Investment Corp. cored 30 ft. of saturated Cypress sand topped at 2,286 ft. The 2 Allen W. Gray estate, NE SE SE 20-8s-14w, 10 miles southwest of Mount Vernon, seems to be the best well in this

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new area that was opened for development last summer.

CALIFORNIA

Tejon Outpost Dry; Two New Tests Start

Reserve Oil & Gas Co. abandoned its 1-mile northeast outpost to the Olcese sand discovery it recorded last May at Tejon Ranch in southeast San Joaquin Valley. Top of the Olcese was encountered at 5,698 ft. but only minor showings were encountered in drilling to 5,824 ft., total depth. Location of the test was in SW SW 23-11n-19w.

Southwest of the nine-well producing area a similar distance, in SE NW Section 33, Drilling & Production Service was nearing the 5,000-ft. level at 33 J.V. Outcome of this test was expected to be determined by late last week.

Two new tests getting under way were J. M. Butler and R. K. Long 15-27 Reserve-Pauley and Lake Oil Co. 1 Crane. The former was a ½-mile northwest stepout in SW NW Section 27. That of Lake was in SW SW Section 34, about 1,000 ft. southwest of Olcese production.

Timber Canyon Outpost

Richfield Oil Corp. has staked 2 Loel-Maxwell as a ½-mile northeast stepout to the Repetto sand discovery it scored last Christmas in the Timber Canyon area, Ventura County. The new test will be in SE NE 18-4n-20w. The discovery, in NW SE Section 18, was completed at 7,856-8,560 ft. for 300 bbl. of 37.3°-gravity crude daily. Further development has been held up pending settlement of certain ownership questions.

Airport Activity Up

Two new locations have been staked for the fault-block pool The Texas Co. scored early this year, at the Long Beach airport, about ½ mile northeast of Signal Hill production. Texaco staked the third well from its N.C.T.-1 drilling island, and was drilling the third well from the N.C.T.-2 drill site. Hancock Oil Co. staked 54 Signal in the industrial area west of the airport, where its 54 Signal was nearing completion in the 9,000-ft. Miocene sand.

New Colusa Gas Field

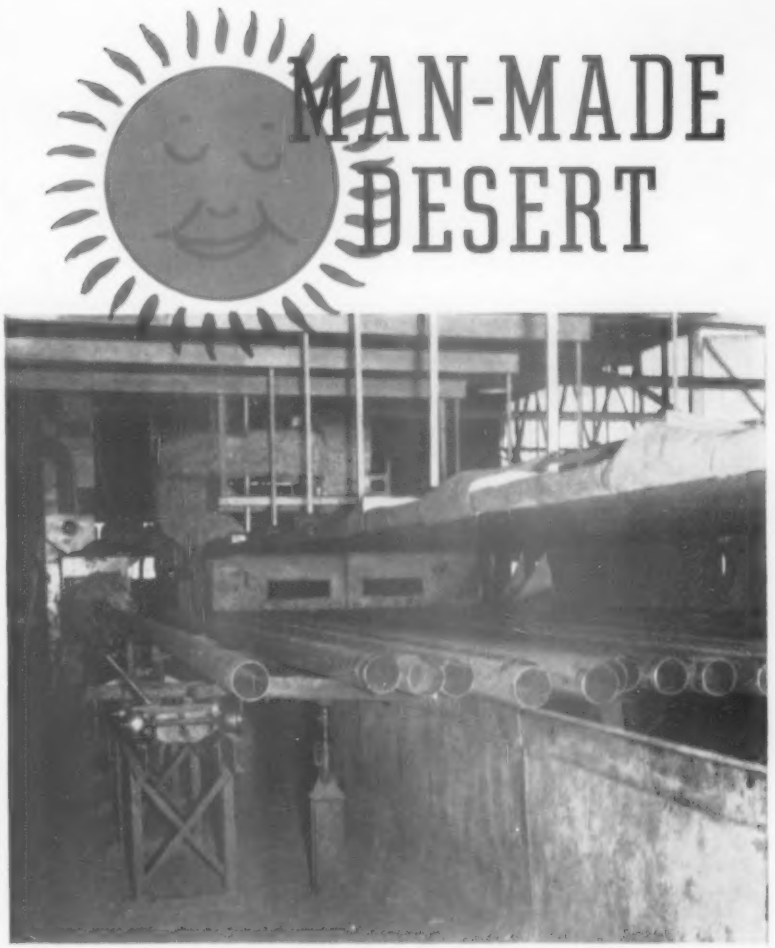
Humble Oil & Refining Co. completed a wildcat in the Colusa area of that county as new gas field discovery. Located in 3-15n-1w, 3 F. J. Steidlmayer flowed 1,535 M.c.f. of gas through a ½-in. choke. Producing interval was 1,378-1,415 ft.

In the Llano Seco area of Butte County, 3 miles northeast of the Beehive Bend field, Humble was attempting to complete 2 Parrott Investment Co. as a new gas find. After drilling to 6,700 ft., hole had been plugged back to 3,669 ft. Location of the prospective discovery is in 4-19n-1w.

ILLINOIS

Four rigs running in the area 2 miles east of Omaha in 24-7s-8e, Gallatin-White counties, make this a very active region. Three Benoist sand wells have recently been completed in the area.

The second well in a new area in Saline



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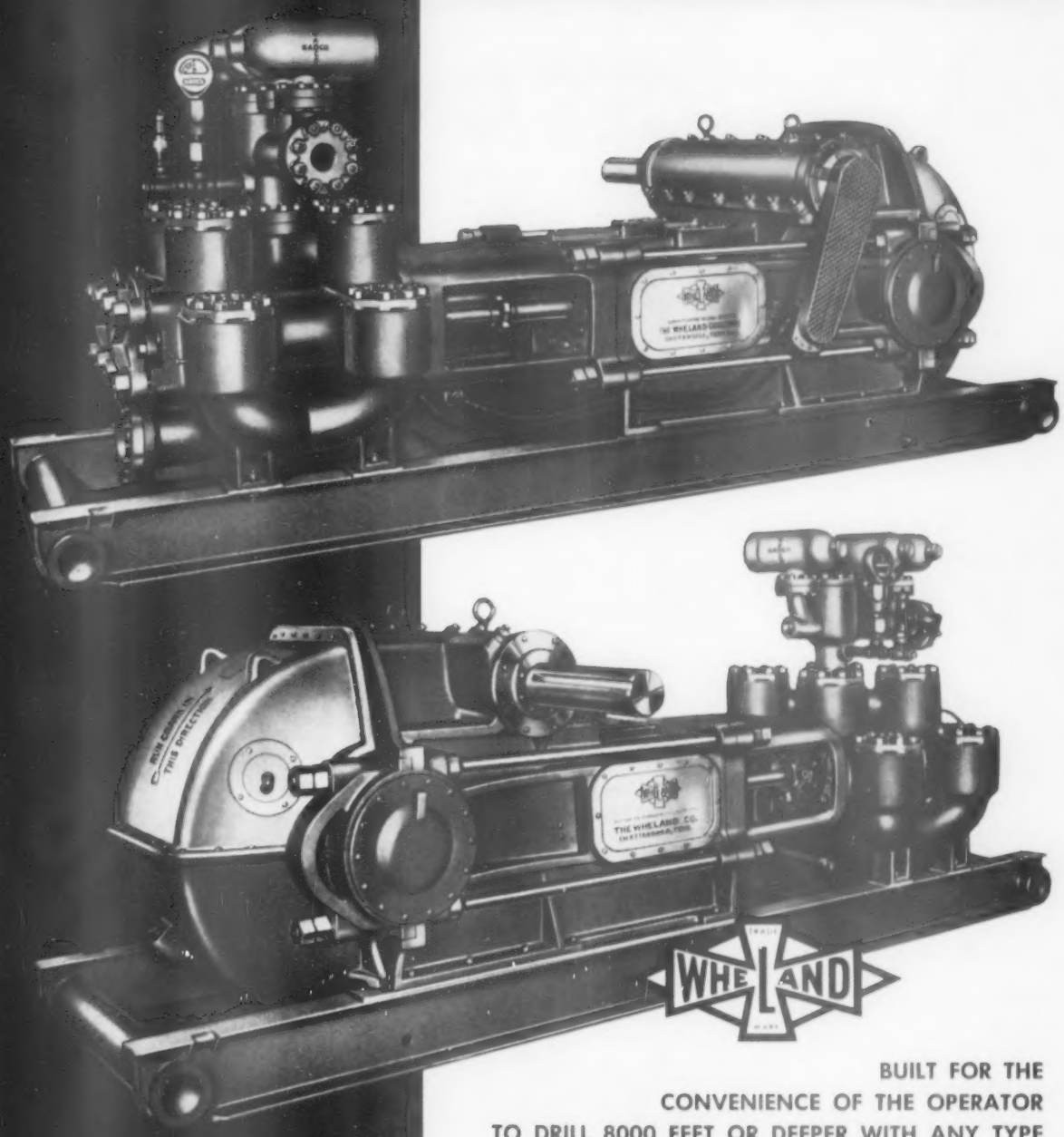

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County, 3 miles northeast of Eldorado, flowed clean oil in 90 minutes on drill-stem test in the Waltersburg sannd. It is Calvert Drilling Co., Inc. 2 Endicott, SE NW SE 2-8s-7e.

LOUISIANA

NORTH LOUISIANA

District Records Two Oil Strikes and New Pay in Month

Two new oil discoveries and one new pay were put on the North Louisiana discovery record for 1954 in October. Four proven areas also received extensions.

Bienville and LaSalle parishes got the new oil fields, while Claiborne added the new pay strike. Concordia, DeSoto and Tensas parishes recorded the extensions.

Cypress Springs fie'd . . . This new oil field was opened in Bienville Parish by Pure Oil Co. at 1 J. B. Smith Unit in the NW 35-17n-7e.

The field discovery well was finaled flowing 238 bbl. of 38.5°-gravity oil per day through 20/64-in. choke from Pettit perforations at 7,022-40 ft. No additional wells have been forthcoming.

LaSalle find . . . This parish got a new oil discovery at Nebo Oil Co., Inc. 12 Nebo fee in 13-8n-1e. It has Wilcox production from perforations at 3,484-94 ft. It flowed 24 bbl. of oil per day plus 97 bbl. of water on 16/64-in. choke. Further wells have not been announced as yet.

Taylor pay . . . This sand is a new pay in Colquitt field, Claibornie Parish. Lion Oil Co. 1 Greer, 34-23n-6w, was completed at 8,949-66 ft. The well flowed 326 bbl. of oil per day plus 17 of water on ⅝-in. choke. Gravity was 58°. Gas-oil ratio was 5,134:1. This gives the field three pay zones, two of them Smackover pays.

Bee Brake field . . . This Concordia Parish field was extended about 1 mile at David Crow, Trustee 1 Quinn, NW SE 24-4n-6e. It finaled on the pump for 113 bbl. of 36.6°-gravity oil per day. The perforations were at 6,721-24 ft. in the Wilcox.

E. C. Wentworth and Como Drilling Co. 1 Crothers, C NW NW 16-4n-7e, a northeast extension at Bee Brake field, flowed 60 bbl. of 41.5°-gravity oil per day from Wilcox perforations at 6,754-58 and 6,760-66 ft. It extends the field ¾ mile.

New Pettit gas . . . Jack W. Grigsby extended Pettit gas production in Bethany-Longstreet field, 5 miles southeast into DeSoto Parish at 1 Schuler estate. The big well flowed 32,500 M.c.f. per day with condensate. Production is from perforations at 6,505-13 ft. It is in 10-13n-15w.

Holly Ridge . . . Tensas Parish's Holly Ridge field was extended 1 mile north at Union Producing Co. 15 Penrod-Jurden, 17-11n-10e. The Wilcox well flowed 65 bbl. of 28.5°-gravity oil per day through 6/64-in. choke from perforations at 3,031-32 ft.

SOUTH LOUISIANA

Jefferson Island Dome Gets New Oil Producer

Stanolind Oil & Gas Co. has a new oil producer on the south flank of the old Jefferson Island salt dome, in Iberia Parish, where its Lemaire, in 58-12s-5e, produced at

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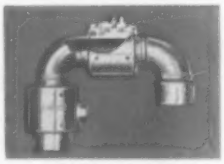

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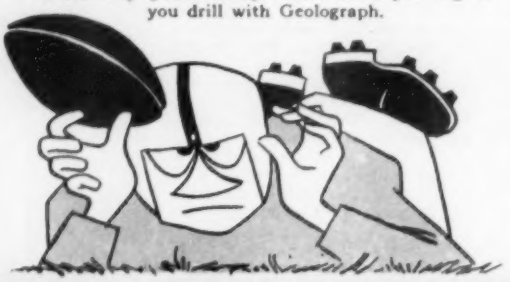

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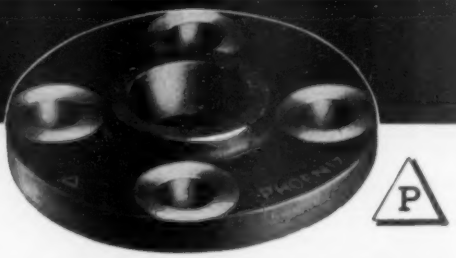

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the rate of 100 bbl. of 35.4°-gravity oil per day on potential gage through 9/64-in. choke. Producing interval is 8,984-94 ft. The well, drilled to 10,256 ft., also tested oil in a deeper sand, perforated at 9,800-12 ft.

CANADA

Three New Gas Fields Opened In Alberta

The California Standard Co. increased its natural gas reserves substantially the past week, with the discovery of that product at three current wildcat drillers in Alberta.

One of the new discoveries was in the Grassy Island Lake area, 40 miles northeast of Hanna. The other two were 4½ miles apart, in the Bentley area, approximately 20 miles west of Lacombe.

The strike in the Grassy Lake area, Cal-Standard 8 Grassy Island Lake, LSD 11, 14-34-8w4, was recorded in the Viking formation.

One of the strikes in the Bentley area, Cal-Standard 4-5 East Gilbey, LSD 4, 5-41-2w5, located 9¾ miles south and slightly west of Rimbey area D3 oilwells, and 4½ miles east of the Seaboard 10-4 Sylvan Lake Viking oil discovery well. This well discovered its gas in the Mississippian limestone, which was contacted at 6,639 ft.

The other discovery in the Bentley area, Cal-Standard 10-7 South Gilbey, LSD 10, 7-40-2w5, 4 miles west of Cal-Standard's 10-11 Bentley abandonment, was also registered in the Mississippian formation.

A well in the Sundre area of Alberta, backed by Hudson's Bay Oil & Gas Co., Ltd., has opened up approximately 50 ft. of oil bearing Mississippian limestone. This well is located about 60 miles northwest of Calgary and 22 miles north-northwest of Olds.

Cleary Oil Co., Ltd., Calgary independent, has found some light gravity oil in the Viking sand at its current step-out driller in the Driedmeat Lake area of central Alberta, 7 miles south of Camrose.

Another well in Alberta discovered gas in the Viking sand foramtion. This well was drilled by the team of Northern Development, Ltd., and L. P. Mann. It is located about 3¼ miles west of the southwest corner of the Redwater oilfield, and 20 miles northeast of Edmonton.

EASTERN CANADA

Ontario . . . In the old Oil Springs field, Lambton County, four injection wells drilled by Nye DeMers and associates in pursuance of their second recovery oil program and bottoming around 375 ft. have been shot. Approximately 150 qt. of nitro was used in each well, widening the hole below 310 ft. from the original 6½ in. to about 3 ft. Following the shots, oil came into the enlarged holes faster than the mud and water could be baled, and production of up to 20 bbl. a day from the completed project is expected, as against a few gallons from the original well.

In the DeMers program four outlying injection wells are drilled with a central production well, and after shooting and cleaning, gas is to be pumped in to provide a pocket between the oil and the water which is to be forced into the injection wells under approximately 1,000-lb. pressure. A water pumping plant is in the final stages of construction.

The first program involved drilling 5 wells to a single acre, but future programs contemplate 1 well to 2½ acres. Cable tools will be used for future drilling. It is estimated that between 36 and 38 million barrels of oil are in the Oil Springs and Petrolia forma-

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tions, and that its complete recovery will take between 15 and 20 years.

If the Oil Springs operations are successful, the DeMers group will start work also on their Petrolia holdings. Eastern Royalties of Bradford, Pa., has an oil recovery program under way already on the Telsey property north of Petrolia, designed to utilize air injection.

ROCKY MOUNTAIN

WYOMING

Grieve Unit Confirmation Tested

Forest Oil Co. reported recovery of oil at the rate of 50-100 bbl. per hour on test of 2 State 22-2 Unit, NE NW NW 22-32n-85w, Natrona County. The well is a confirmation to the operator's recent discovery which flowed through choke at a rate of more than 1,000 bbl. per day at completion.

Test in the second well was of the interval 6,663-6,708 ft. Flow was through ¼-in. choke and time and pressures were not reported. The current success is ½-mile northwest of the discovery. Producing zone in the discovery was identified only as Cretaceous. Forest is now drilling at 3-28-1 Unit, C NE SW 28-32n-85w, which is scheduled to go to basement.

Ralston Unit Wildcat Flows From Phosphoria

Sun Oil Co. gaged a flow of 251 bbl. of oil per day on test of Phosphoria at 1 Ralston Unit, C NE NW Tract 51-56n-101w, Park County. Production is from Phosphoria and through perforations at 12,640-80 ft. Test followed acidization. The well was deepened from a former producing zone in third Frontier, and went to total depth of 13,299 ft.

Casing Run At Sublette County Wildcat

El Paso Natural Gas Co., Continental Oil Co. and others are running 7-in. casing at 1 Unit, C NE SE 9-30n-108w, Sublette County. The wildcat, on the Pinedale anticline, one of Wyoming's largest surface structures is at total depth of 9,676 ft. It was scheduled as a 15,000-ft. test. Shows of gas were reported below 8,500 ft., believed to be in Tertiary. Tops and tests have not been reported, but according to apparently reliable reports in circulation, the best gas recovery on tests to date was 170,000 cu. ft. per day.

Hot Springs County Gas Discovery Completed

Mobil Producing Co. has completed F-22-32-G, C SE NW 32-45n-99w, in the Skelton Dome area, Hot Springs County for a flow of 1,150,000 cu. ft. of gas per day. Production is from third Frontier. The well was drilled to a total depth of 7,030 ft. in Tensleep and plugged back for completion to 3,688 ft.

COLORADO

Logan County Discovery Shows High Potential

Frontier Refining Co. tested a flow of 235 bbl. of oil in 4 hours at 1 Frasco-2, C NE NW 4-7n-55w, Logan County. The well was

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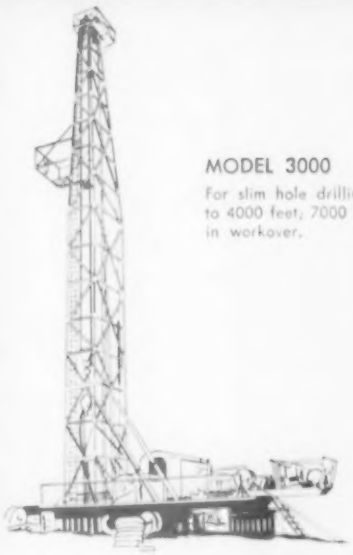

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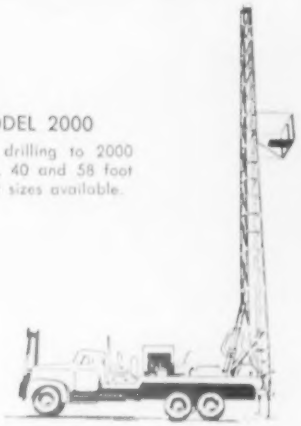

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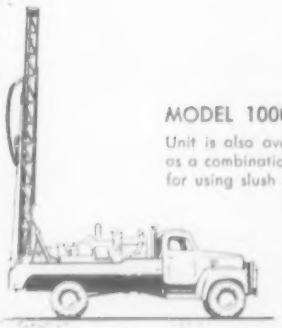

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The entire batch of SOS slurry is pre-mixed in truck-mounted, paddle-mixing tanks. This method provides a smooth oil-cement slurry of any density the operator desires. Then high-pressure, triplex pumps are used to inject the slurry into the formation.

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For full information on Slurry Oil Squeeze call your nearest Dowell office or write DOWELL INCORPORATED, Tulsa 1, Oklahoma, Dept. K-11.

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perforated in the "J" sand zone 5,535-39 ft. The operator has shut the discovery down for installation of storage.

The well is 2 miles northwest of Pawnee Hills production, and in an area of Logan County which has had relatively little previous drilling.

Good Producer Tested In Adams County

S. D. Johnson and Cosden Petroleum, Inc. recovered 246 bbl. of oil in 10-hour test of 1 Rosener, SE SE SW 12-1s-59w, Adams County. Production is from "D" sand perforations at 6,120-24 and 6,125-29 ft. The operators recovered only 240 ft. of oil and 60 ft. of heavily oil and gas-cut mud on drill-stem test of the two saturated zones before pipe was set. The well was Sandfract before the 24½ bbl. per hour flow was tested.

This discovery is west of Little Beaver-Badger Creek and about 3 miles west of Leader field.

Jackson County Discovery Swabs

Lion Oil Co. swabbed 270 bbl. of oil in 16 hours at 1 Dwinell, C NE SW 23-10n-79w, Jackson County. Test is of Dakota at 4,561½-69½ ft. The zone was Sandfract before swabbing. Tests have not been run in Lakota, which also had commercial recoveries on drill-stem tests.

NEBRASKA

Rank Banner County Discovery Tested

Rex Petroleum Co. recovered oil at the rate of 110 bbl. per day on initial swabbing of 1 Johnson estate, C SW NE 27-18n-53w, Banner County. The well is about 12 miles southeast of production in Harrisburg field and 9 miles north of production in Kimball County. Recovery was from "J" sand. Perforations are at 5,462-68 ft.

Discovery Swabs 120 BOPD

James P. Slosa, Denver independent, swabbed at the rate of 120 bbl. of oil per day at 2 State, C NW NW 36-14n-55w, Kimball County. Test was through perforations 6,216-23½ ft., in "J" sand. Test followed Sandfrac. Prior to treatment the well swabbed at the rate of 2 bbl. per hour.

Kimball County Wildcat Swabbing

Rock Hill Oil Co. and Twin Oil Corp. recovered 300 bbl. of fluid, 90 per cent oil in 8-hour swab test of 1-A Vrtatko, NE NE SE 7-13n-54w, Kimball County. Production is from "D" sand through perforations 6,002-10 ft. Grind out was 10 per cent water, and the operators are continuing to swab. At initial perforation of the zone 6,009-10 ft. there was a 3,500 ft. fillup in 1 hour. Cores recovered a 14-ft. saturated sand section. The well is 3 miles east of Enders field, where production is from "J" sand.

MONTANA

Daniels County Wildcat Drilling In Mississippian

Zach Brooks is drilling below 6,300 ft. at 1 State, C SE SE 18-36n-44e, in the Richland area of Daniels County. The well is reported in Mississipipan at this depth, and no shows have been reported. It is scheduled to test to about 8,500 ft.

Confirmation Located In East Little Beaver Area

Shell Oil Co. has made location for a confirmation attempt at its East Little Beaver discovery in Fallon County. The new well is 32-X-6-B, NW NW NE 6-4n-62e. It is a

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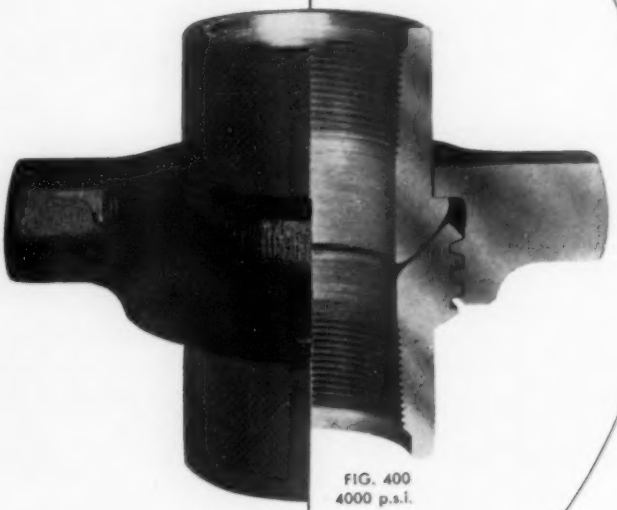

FIG. 400
4000 p.s.i.

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southwest offset to the discovery well, which was completed for 209 bbl. of oil per day from Ordovician. The area was previously known as the MDU area.

MISSISSIPPI

Third Well Completed In New Bolton Paluxy Field

Stanford-Wells-Lutken 1 Mashburn, west offset to the discovery well of the new Bolton field, 12 miles west of Jackson, in western Hinds County, has been completed as the field's third producer.

The well is rated at 254 bbl. of 38°-gravity oil per day, flowing through ⅛-in. choke with pressure of 825 psi. and gas-oil ratio of 70 cu. ft. per barrel. Casing is perforated at 9,909-13 ft., 9,915-19 ft., and 9,921-26 ft. in the field's Paluxy (Lower Cretaceous) pay zone.

A south offset to the discovery well was completed a month ago by Sun Oil Co. Discovery well, drilled by Larco Drilling Co., was completed last July as the state's first Paluxy producer.

Six other tests are drilling in the immediate area including two, north and east offsets to the discovery well, which have passed the Paluxy zone as commercially unproductive. One of the latter, the north offset (Magnolia Petroleum Co. 1 Cockrum), got indications of commercial production in the deeper Glen Rose section but is drilling ahead.

WILDCAT COMPLETIONS

SOUTHWEST TEXAS

District 1

Atascosa County: Republic Natural Gas Co. 1 Pfeill, Block 27, Natascosa Colony Farms Subd. Dry. TD 1,600 ft.

R. P. Trubey 1 Miers, Henry Hiner Sur. 521, A-405. Temporarily abandoned. TD 5,319 ft.

Bexar County: Alamo Royalty Co. 1 McCreless, M. Monjaros Sur. 6, A-463. Dry. TD 1,619 ft.

Karl Arnold 3 Dillon, A. G. May Sur. 216. Dry. TD 3,500 ft. Precision Prospecting, Inc., et al 1 Cover, Michael Gotaris Sur. Dry. TD 1,255 ft.

Dimmit County: B. G. Byars and C. G. Dunwoody, Jr., 1 Rhodes, T&NO Sur. 20, A-1532. Dry. TD 3,300 ft.

Frio County: Alaska Steamship Co. 1 Sartain, W. O. Winston Sur. 310, A-670. IPP 96 BOPD, 31.7°, open hole 5,515-5,780 ft. TD 5,780 ft. (Extends Pearsall area.)

Gonzales County: O. Neathery, Jr., et al 1 Baldridge, David McCoy Sur., A-43. Dry. TD 5,500 ft.

O. Neathery, Jr., et al 2 Baldridge, David McCoy Sur., A-43. Dry. TD 4,700 ft.

Sutton Drilling Co. 1 Smith, Sarah Smith Sur., A-415. Dry. TD 2,307 ft.

Guadalupe County: Harry B. Baker 1 Cale, J. Leale Sur. 91, A-211. Dry. TD 610 ft.

McMullen County: Producers Corp. of Nevada and Seeley 1-A Horton, James M. Jean Sur., A-281. Dry. TD 667 ft.

Wilson County: J. B. Vassey 1 Reinhardt, Francisco Hererra Sur., A-15. Dry. TD 2,357 ft.

District 4

Cameron County: Superior Oil Co. 11-I San Benito Unit, Drilling Block 11, City Block 72, San Benito townsite, Fernandez

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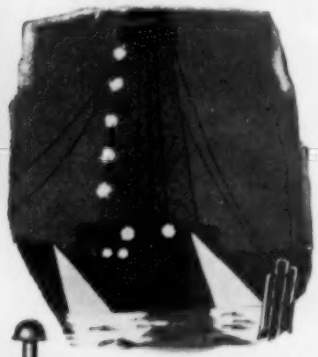

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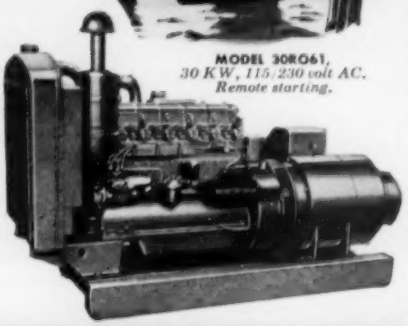

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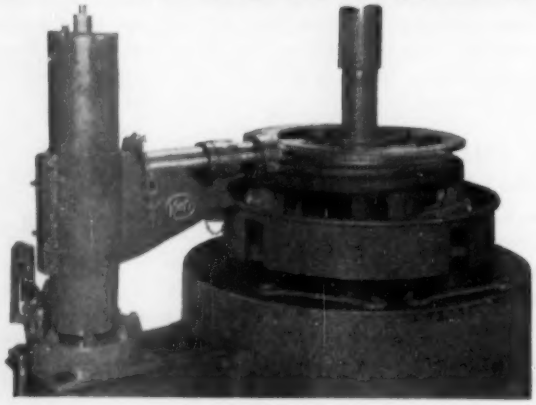

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WILDCAT COMPLETIONS

and Bartolone Sur., A-16. Dry. TD 10,629 ft.

Duval County: Kirkwood & Co., Roman S. Waldron, and Carlton Weaver 1 Duval County Ranch Co., Tract 5, GC&SF Sur. 258. Dry. TD 6,015 ft.

Jim Hogg County: E. J. Pearl 1 I. A. Trevino estate, Share M-4, Las Cuevitas Grant. Dry. TD 2,253 ft.

Jim Wells County: H. R. Smith et al 1 Schmidt, Block 2, Welhausen & Driscoll Sub., Casa Blanca Grant. IP 72.65 BOPD, 9/64-in., 35.2°, perforations 4,879-85 ft. TD 4,915 ft.

Nueces County: Lewis Kelsey and H. G. Spiller 1 Atkinson, Sec. 51, George H. Paul Subd. Dry. TD 6,992 ft.

San Patricio County: Southern Minerals Corp. 2 Anderson, Torbio Molino Sur., A-18. Dry. TD 6,014 ft.

Starr County: Hiner & Clark 1 Adala Ramirez de Pena et al, Block 51, E. K. Bateman Subd., El Pedernal Grant. Dry. TD 1,950 ft.

Webb County: Bridwell Oil Co. 2 Bruni estate, Block 71, Brown Subd., Albercas Grant. Dry. TD 5,773 ft.

Parr & Delaney Oil Co. 1-C Parr, Blocks 20 and 20½, San Casimiro Grant. IPP 26 BOPD, 20.7°, open hole 867-80 ft. TD 880 ft. (New field—San Casimiro.)

Zapata County: Miller & Pierce 1 Noyes Smith et al, Section 1, El Javali Grant. Dry. TD 2,009 ft.

TEXAS GULF COAST

District 2

Bee County: Pratt-Hewit Oil Corp. 1 Thomas Weidel, J. W. Cook Sur., A-450. Dry. TD 4,309 ft.

Ussery Drilling Co., and Haas & Brown 1 Wood, Section 23, S. Turner Sur. Dry. TD 5,606 ft.

Calhoun County: American Liberty Oil Co. 19-1 Hawes et al, William Little Sur. 19, A-113, Matagorda Island. Dry. TD 6,819 ft.

Jackson County: Southern Minerals Corp. 1 State Tract 7, Josiah H. Bell Sur. IP 106.26 BOPD, ⅛-in., 40.3°, perforations 8,070-75 ft. TD 8,508 ft. (New field—West Swan Lake.)

District 3

Burleson County: A. B. Alek 1 Harriston, Abner Smith Sur., A-209. Dry. TD 3,663 ft.

Chambers County: Panuco Oil Leases, Inc., and Michel T. Halbouty 1 Lawrence, Lot 5 of Re-Partition of Lots 6, 7, 8, and 9, James Lawrence Island Sur., A-168. Dry. TD 9,002 ft.

Fayette County: Sutton Drilling Co. 1 Derry, Adam Zumwalt Sur. Dry. TD 1,956 ft.

Hardin County: General Crude Oil Co. and E. Cockrell, Jr. 1 Ormsby, William W. Young Sur. (Sour Lake area). Dry. TD 11,133 ft.

Harris County: Haynes B. Ownby Drilling Co. et al 1 Odelia Staiti trust, W. M. Hardin Sur., A-24. Dry. TD 8,512 ft.

Liberty County: Michel T. Halbouty 1 Partlow, John R. Fault Sur., A-34. Dry. TD 8,368 ft.

Matagorda County: Brazos Oil & Gas Co. 1 Crouch, J. C. Hurd Sur., A-198 (Blue Creek prospect). Dry. TD 8,512 ft.

Wharton County: Brazos Oil & Gas Co. and Sinclair Oil & Gas Co. 1 Connor et al, John Bagnal Sur. 82, A-497. Dry. TD 7,955 ft.

Colorado Oil & Gas Corp. and Acco Oil & Gas Co. 1 Duncan, D. Wade Sur., A-64. Dry. TD 7,605 ft.

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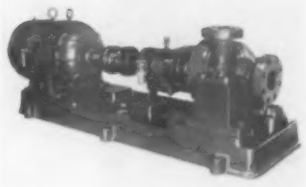

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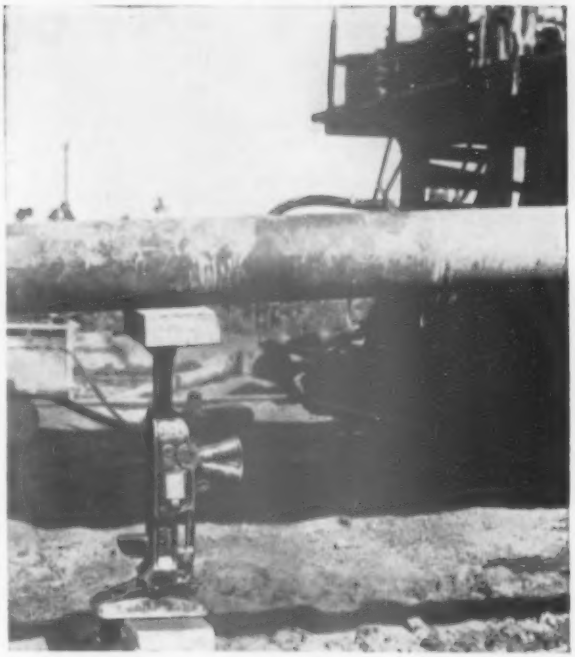

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WILDCAT COMPLETIONS

Inc., ETRR Sur. 20, A-558. Dry. TD 7,162 ft.

EAST TEXAS

Anderson County: Stroube & Stroube and R. E. Smith 1 Davey, M. Kay Sur., A-459. Dry. TD 2,280 ft.

Freestone County: Stroube & Stroube 2 Mona Edens, J. Roque Sur., A-525. Dry. TD 3,817 ft.

Navarro County: Edson Petroleum Co. 1 Smith estate, N. Hawkenberry Sur., A-343. Dry. TD 3,605 ft.

TEXAS PANHANDLE

Collingsworth County: Latch 1 Collett, 22-2, H&GN. Dry. TD 2,602 ft.

Hansford County: Fulton 1 Lasater, 45-62, H&TC. IPF 498 BOPD, Morrow, ¾-in., 39.5°. TD 7,512 ft. (Oil discovery).

WEST CENTRAL TEXAS

Callahan County: Ernest Fletcher 1 Maltby, Sec. 33, D&DA Sur. Dry. TD 3,450 ft.

Fletcher Oil & Gas Drilling Corp. 1 Eager, R. A. Pennell Sur. 755. Dry. TD 3,917 ft.

Pure Oil Co. 1 Hewes, Lavaca CSL Sur. 6. Dry. TD 4,216 ft. Elev. 1,814 ft., Ellenburger 3,970 ft.

Coleman County: Maner Graham 1 Purcell, Blk. 3, Samuel Wilson Sur. 708. Dry. TD 3,239 ft.

Womer-Tilton Oil Co. 1 Smith, Sec. 29, BBB&C Sur. Dry. TD 3,305 ft.

Eastland County: J. R. Lind 1 C. H. Fee estate, 76-4-H&TC, 2 mi. NE Cisco. IP 97 BOPD, 12/64-in., TP 175 psi., GOR 397, pay 3,654-58 ft. TD 3,945 ft.

Haskell County: O. E. Hall 1 Walla, 75-1-H&TC. Dry. TD 6,119 ft.

Jones County: Elm Oil Co. 1 Frank Carter, 33-18-T&P, 10 mi. NW Merkel. IPP 39 BOPD, 37°, pay 4,146-63 ft. TD 4,981 ft.

Thos. D. Humphrey & Son 1 Crow, Sec. 24, D&DA Sur. Dry. TD 2,842 ft.

M. D. St. John 1 Steele, Blk. 47, Harrison CSL Sur. 334. Dry. TD 3,132 ft.

NORTH TEXAS

Archer County: Archer Drilling & Production Co. 4-D Cowan & McKinney. Blk. 160, R. Carson Sur. Dry. TD 1,397 ft.

Archer Drilling & Production 5-D Cowan & McKinney, Blk. 160, R. Carson Sur. Dry. TD 1,294 ft.

Archer Drilling & Production 2 Prideaux, S. H. Smith Sur., A-370. Dry. TD 729 ft.

Archer Drilling & Production 3 Prideaux, S. H. Smith Sur., A-370. Dry. TD 696 ft.

James W. Harvey 1 Cowan & McKinney, R. Hackett Sur., A-173. Dry. TD 1,285 ft.

James W. Harvey 4 Cowan & McKinney, T. P. Glass Sur., A-141. Dry. TD 1,230 ft.

L. S. D. Oil Co. 1 Parkey, G. Brigman Sur., A-1186. Dry. TD 1,471 ft.

Presley Lomax 1 Seay, Blk. 56, Harris Subd., 8 mi. W Archer City. IPP 30 BOPD, 34°, pay 1,156-60 ft., TD 1,195 ft.

Jack County: George Hood Elliott 1 Bloodworth, Matthew Miller Sur., A-418. Dry. TD 4,001 ft.

Wright, Clark & Senkel, Inc. 1-A Walden, A. S. Ensworth Sur., A-1789, 3 mi. SW Bryson. IPP 26 BOPD, 39°, Strawn pay 2,953 ft. TD 3,007 ft.

Wichita County: W. H. Hammon 2 Rathgeber estate, Blk. 14, K&N Subd., 6 mi. S Wichita Falls. IP 478 BOPD, 11/64-in., TP 350 psi., GOR 400, Vogtsberger sand 4,841 ft. TD 4,860 ft.

Wilbarger County: Dublin-Kiel 1 Brown-Castlebury, 67-14-H&TC. Dry. TD 1,967 ft.

R. W. McDonnell 1-A Waggoner, 59-4-H&TC. Dry. TD 2,510 ft.

Young County: R. W. Darden 1 Morrison, TE&L Sur. 159. Dry. TD 1,125 ft.

Duval & Terry 1 Gose, Blk. 313, TE&L, A-560. Dry. TD 1,014 ft.

Duval & Terry 1 King, TE&L Sur. 313, A-560. Dry. TD 1,603 ft.

Homer Goetz 1 Thresher, Sec. 251, TE&L Sur. Dry. TD 750 ft.

A. F. Knappenberger 1 Knight, R. Hamilton Sur., A-1321. Dry. TD 2,804 ft.

Tennessee Production Co. 1-C Stewart, Blk. 3, Young CSL. Dry. TD 3,619 ft.

WEST TEXAS

Andrews County: Continental Oil Co. 1 University "6-17," 17-6-University Lands Sur. Dry. TD 12,600 ft. Elev. 3,006 ft., Strawn 10,994 ft., Mississippian 11,555 ft., Devonian 12,512 ft.

Crockett County, American Trading & Production Co. 1-D University, 7-13-University Lands Sur. Dry. TD 3,937 ft.

Pan American Production Co. 1 West, 1-A-Runnels CSL Sur., 12 mi. N Ozona. IP 256 BOPD, 16/64-in., 44°, TP 600 psi., GOR 1,550, perforated Ellenburger 8,072-88 ft. TD 8,100 ft.

Crosby County: Ohio Oil Co. 2 Morgan Jones, 120-2-H&GN. Dry. TD 8,215 ft. Elev. 2,471 ft., Ellenburger 8,420 ft., pre-Cambrian 8,507 ft.

Midland County: Forest and Cities Service 1 Dora Roberts B-1, 42-41-T2S-T&P, 5 mi. SE Odessa. IP 2,163 BOPD, 1-in., TP

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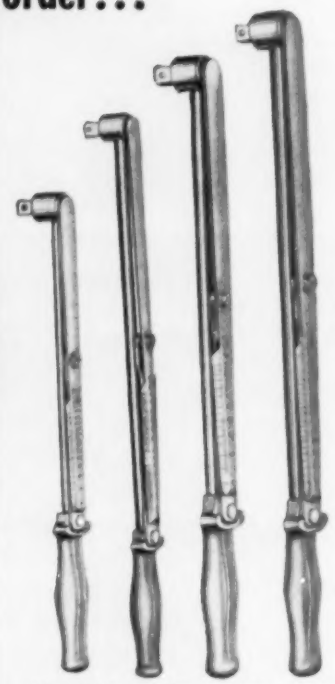

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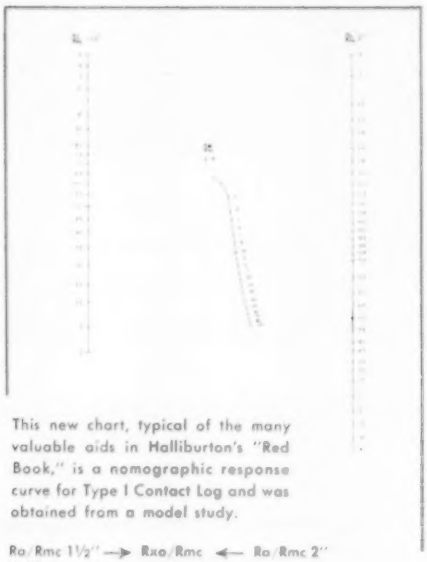
Halliburton Method Replaces Slide Rule Work For Interpreting Electrical And Contact Logs



This new chart, typical of the many valuable aids in Halliburton's "Red Book," is a nomographic response curve for Type I Contact Log and was obtained from a model study.

Ro/Rmc 1½" → Rxo/Rmc ← Ro/Rmc 2"
d 9"

Ro Apparent resistivity from the contact log, ohm-meters
Rmc Mud cake resistivity, ohm-meters
Rxo Resistivity of flush zone immediately behind mud cake, ohm-meters

To help you with quantitative studies, Halliburton developed this new "red book" of interpretation charts—important tools for easy, quick analyzing of electrical and contact log data. The book of charts is available in Halliburton's courses of instruction for customers interested in reservoir studies. Practical application of these new charts, which replace much slide rule and mathematical work, is one of the many helpful subjects discussed by Halliburton engineers to help geologists and other specialists who deal with this complex and highly valuable technique.

Halliburton engineers realize that quantitative analysis, while one of the major achievements of recent years, is still a quasi-science that can not always provide a precise evaluation of exploration wells. Many errors in interpretations are based on incomplete knowledge, assumptions that are not supported by field experience and inexact solution methods. With these limitations in mind, Halliburton engineers developed the new interpretation charts and offer realistic courses of instruction to help you in making quantitative studies that are more accurate, easier to use and more effective under applicable conditions.

These new aids, based on field experience and extensive research programs, are practical examples of Halliburton's interest in improving the standards of quantitative interpretation. To learn how Halliburton achievements in Electrical Well Service tools, research and interpretation can directly benefit you and your company, or if you want to join a school using this text, contact your local or district office of the Halliburton Oil Well Cementing Company.

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WILDCAT COMPLETIONS

400 psi., GOR 1,134, 52°, pay 12,835 ft. TD 13,012 ft. Ellenburger discovery.

Magnolia Petroleum Co. 1 Nobles, 28-40-T1S-T&P, 5 mi. NW Midland. Dry. TD 13,538 ft. Elev. 2,931 ft., Devonian 12,032 ft., Ellenburger 13,358 ft. Sample tops.

Reagan County: C. A. Jones 1 Carr, Sec. 8, GC&SF Sur., A-901, 1 mi. NE Big Lake. IPP 5 BOPD, 32°, pay 2,644 ft. TD 2,776 ft.

Scurry County: Texas Crude Oil Co. et al 1-288 Brumley, 288-97-H&TC. Dry. TD 7,280 ft. Elev. 2,501 ft., reef 7,177 ft.

Sterling County: J. H. Elder 1 Foster, 28-22-H&TC. Dry. TD 1,788 ft.

Upton County: Humble Oil & Refining Co. 1 Halff, 20-Y-GC&SF, 19 mi. NW Ranger. IP 408 BOPD, 19/64-in., TP 300 psi., GOR 930, 42.8°, Wolfcamp 8,967-9,018 ft. TD 9,025 ft.

WEST TEXAS BORDER COUNTIES

Fisher County: J. J. Lynn 1 Martin, 12-1-H&TC. Dry. TD 6,475 ft. Elev. 1,752 ft., Ellenburger 6,255 ft., Cambrian 6,420 ft.

Trans-Tex Drilling Co. 1 Ubben, Bastrop CSL Sur. Dry. TD 5,732 ft. Elev. 1,891 ft., Flippen 3,443 ft.

Nolan County: C. L. Norsworthy 1 Paramore, 83-1A-H&TC. Dry. TD 7,513 ft.

SOUTHEAST NEW MEXICO

Eddy County: Ibex Oil Co. 1 Hanson-Federal, 25-26s-31e, 1¼ mi. NW North Mason field. IP 44 BOPD, ¼-in., 42°, Delaware sand 4,139 ft. TD 4,147 ft.

Stanolind Oil & Gas Co. 1 Welsh Unit, 21-26s-27e. Dry. TD 12,547 ft. Elev. 3,245 ft., Bone Springs 5,665 ft., Wolfcamp 8,945 ft., Pennsylvanian 11,200 ft.

ILLINOIS

Bond County: E. G. Weeker 1 Donk Bros. Coal Co., SE NW SW 34-6n-4w. Dry. TD 1,976 ft.

Christian County: A. Valters 1 Driskell, NE NE SE 17-15n-3w. IPP 164 BOPD, Hardin 1,663-69 ft., Silurian 1,682-94 ft. TD 1,694 ft. (Opens Edinburg West pool).

Jackson County: Calvert Drilling Co. 1 Heipe, SW NE NW 10-8s-1w. Dry. TD 2,382 ft.

Marion County: J. H. Hall 1 Stevenson, NW NW SE 6-2n-4e. Dry. TD 2,860 ft.

E. E. Spencer 1 Spencer-Ebe, SE NE NW 13-2n-4e. Dry. TD 2,960 ft.

White County: Arrow Drilling Co. 1 Brown, SE SE NE 34-5s-9e. IPP 6 BOPD, Penn. sand 1,208-20 ft. TD 3,302 ft. (Oil well).

Will County: R. Edwards 1 McClintoch, SW NW SW 34-35n-9e. Dry. TD 165 ft.

INDIANA

Daviess County: M. Chapman 1 Meurer, NE SE SW 34-5n-7w. Dry. TD 1,003 ft.

Dubois County: F. L. Beard 1 Blessinger, SW NW NE 15-2s-5w. Dry. TD 1,387 ft.

Gibson County: T&H Corp. 1 Princeton Mining Co., NE SE NW 33-2s-11w. Dry. TD 2,838 ft.

Posey County: K. Lindskog 1 Willoughby-Westfall, NE NW SE 20-4s-12w. Dry. TD 2,848 ft.

TENNESSEE

Anderson County, Briceville: David et al, Coal Creek Mining & Manufacturing 1, NE NE NE 22-4s-64e. Gas 3,107 ft. TD.

Pickett County, Travisville: Buckner, J. P. Upchurch 1. Dry. TD 1,700 ft.

KENTUCKY

Butler County: G. E. Nelson 1 Givens, SW NE SE 14-H-33. Dry. TD 619 ft.

2 Givens, NE SW SE 14-H-33. Dry. TD 170 ft.

H. Jenkins 1 Givens, SE NE SW 15-H-33. Dry. TD 370 ft.

McLean County: G. S. Engle 1 Ashby, NE NW SE 5-N-26. Dry. TD 2,531 ft.

Union County: Engle 1 Boswell, SE SW SW 18-O-18. Dry. TD 2,846 ft.

MICHIGAN

Clare County: W. B. Stewart & Basin Oil Co. 1 Shull estate, NW NW NW 22-18n-3w. Dry. TD 5,344 ft. in Richfield.

Crawford County: E. E. Brehm 1 Wells & Schjotz, N½ SE SW 2-25n-4w. Dry. TD 4,549 ft. in Richfield.

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Stopped Standpipe Valve Sanding-Up on Falcon Seaboard Rig No. 29

"Our 4 in. MUDWONDER has more than paid for itself with savings in down-time and parts on these last four wells," says Toolpusher E. A. (Blackie) Blackwell, "and it is still working perfectly—holding pressure as well as the day we put it on."

In the Anse Le Bute and Church Point fields where the Falcon-Seaboard Drilling Company Rig No. 29 has been working, sand is often quite a problem. According to "Blackie" de-sanding the standpipe valve at least once every hole and replacing parts was a necessary and costly practice until he bought a MUDWONDER for the standpipe.

Now "four holes" old, the MUDWONDER has required no maintenance and still works easily and positively. Even if it should need a part replacement in the near future, the job can be done quickly and easily. The one-piece MUDWONDER body stays in the line and only one wrench is needed to remove the bonnet.

Is it any wonder that "Blackie" and his crew are convinced MUDWONDER mud valves are best?

On standpipes, jet guns, pump discharges, whatever your troublesome service is you will cut costly down-time and part replacements with competitively-priced MUDWONDER mudline valves. Ask your favorite supplier or use the coupon below for complete details, today.

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Send me your latest MUDWONDER catalog and price list for 3000 psi WP (6000 psi test) and 2000 psi WP (4000 psi test) mudline valves.

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Company_____ Title_____

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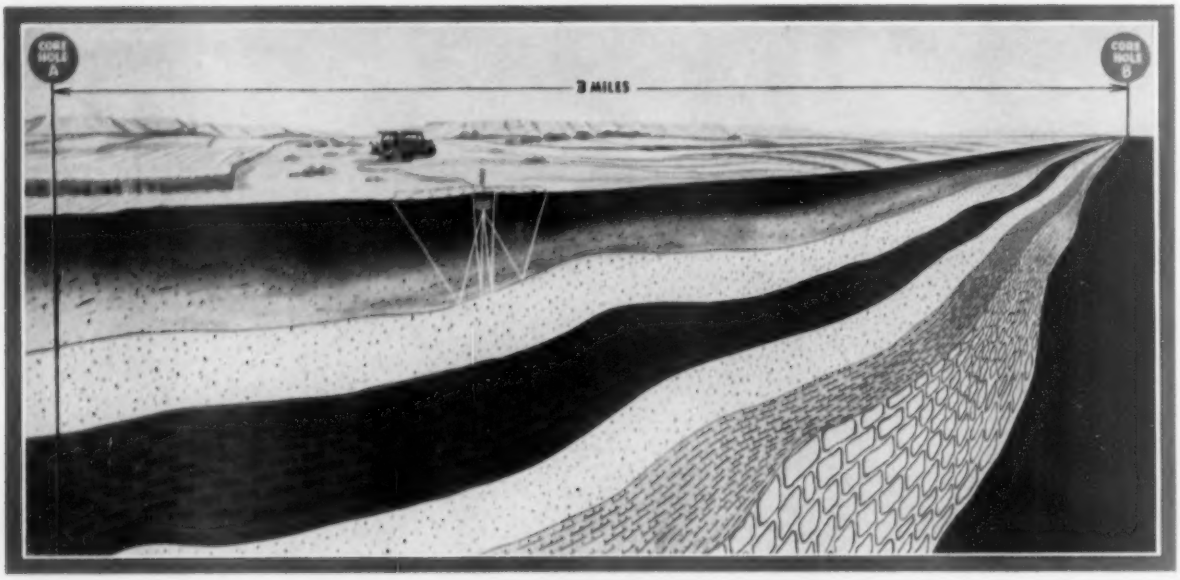

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Core hole intervals can be materially increased when a GSI HR program between holes provides correlation data and effectively reduces costs of near-surface information. HR (high resolution) surveys are a new GSI service which makes available a new range of seismic information in the 100 ft. to 2500 ft. section. When you have an extensive core hole program outlined, let GSI show you how HR work will extend your drilling budget. HR equipment *plus* GSI qualified personnel give you more useful data.

write for Bulletin No. S-303 describing the HR System used by GSI.

GSI HR services also furnish reliable reflection and refraction seismic data in problems of mining, ground water location, and civil engineering where shallow seismic information is important.

Other applications of this new service for shallow seismic data:

- ★ To establish near-surface velocity control
- ★ To furnish near-surface structural information
- ★ To determine base of weathering
- ★ To determine thickness of gravels, glacial drift, and other unconsolidated materials

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WILDCAT COMPLETIONS

Mecosta County: Gulf Refining Co. 1 Ralph Unit, NE SW NW 8-16n-7w. Dry. TD 5,181 ft. in Richfield.

Van Buren County: B. W. Yasdick, Trustee 1 Plott, SW SE NE 32-4s-14w. IPP 7 BOD, Traverse 966 ft., pay 966-69 ft. TD 969 ft. (New pool.)

OHIO

Stark County: Natural Gas West Virginia 1 W. Roudebush, Section 26, Paris Township. Dry. TD 5,580 ft., in Clinton.

PENNSYLVANIA

Westmoreland County: Unity Township Peoples Natural Gas Co. 1-4017 J. A. Mills. Dry. chert 8,038 ft. TD 8,255 ft.

NEW YORK

Chemung County: S. Breene, Trustee 1 Charles Young, Waverly Quadrangle, Sec. E, 16,900 ft. from east section line, 1,300 ft. from north section line. Dry. TD 3,768 ft. Oriskany top 3,594 ft.

WEST VIRGINIA

Randolph County, Middle Fork district: Washington Natural Gas Co. 3-5 E. S. Newlon heirs, 73,000 cu. ft. gas, Fifth sand. TD 2,521 ft.

MISSISSIPPI

Amite County: Clay Oil & Gas Corp. and Peterson Drilling Co. 1 Sherman Huff heirs et al, 18-4n-1e. Dry. TD 7,010 ft. Elev. 171 ft., Wilcox 4,730 ft., base Baker shale 6,498 ft.

Wayne County: Lyle Cashion Co. and R. Stanley 1-E Board of Supervisors, NW NW SW 16-10n-17w. Dry. TD 4,767 ft. Elev. 199 ft., Eutaw 4,538 ft., Stanley zone 4,713 ft.

SOUTH LOUISIANA

Cameron Parish: Pan American Production Co. and Austral Oil Exploration Co., Inc., 1 Lacassine, 1-12s-5w. IP (estimated) 50 BCPD and 3,700 M.c.f. daily, ¼-in. perforations 9,632-48 ft. TD 15,043 ft. (Extends Thornwell field.)

St. Martin Parish: Humble Oil & Refining Co. 1-J Goodrich et al, 33-14s-12e. IP 48 BCPD and 3,135 M.c.f. daily, ⅝-in., perforations 12,584-97 ft. TD 13,053 ft. (New field.)

Terrebonne Parish: Tide Water Associated Oil Co. 2 Elfert Unit, 5-17s-17e. IP 40 BCPD and 5,800 M.c.f. daily, 14/64-in., 46.4°, perforations 10,148-54 ft. TD 12,752 ft. (New pay in Hollywood field.)

NORTH LOUISIANA

Bienville Parish: Atlantic Refining Co. 1 Hamner, 5-17n-7w. IPF 1,750 M.c.f. of gas per day and 8 BC per million, ¼-in., Travis Peak 6,980-88 ft.; 1,700 M.c.f. and 6 BC per million, ¼-in., Travis Peak 7,286-98 ft. TD 7,586 ft. (East extension to Ada field).

Claiborne Parish: F. B. King 1 Jarrell, C NW SE 35-22n-6w. Dry. TD 8,630 ft.

ARKANSAS

Arkansas County: Continental Oil Co. 1 Dewitt Bank & Trust Co., C NE NE NE 32-5s-2w. Dry. TD 4,520 ft.

1 Con Cunningham, C SE SE SW 3-6s-2w. Dry. TD 4,607 ft.

Scott County: Critchell, Parsons & John C. Robbins 1 Wilson heirs, C SW NE 19-3n-29w. Dry. TD 3,050 ft.

OKLAHOMA

Beckham County: B. B. Burke 1 Thomas, SE SE SW 23-8n-22w. Dry. TD 1,585 ft.

Caddo County: AnSon Petroleum Co. 1 Anagoon, SW SW SW 14-5n-12w. Dry. TD 3,085 ft.

Comanche County: W. T. Waggoner, Jr. 1 Couch, SW SW SE 1-1n-10w. Dry. TD 1,902 ft.

Garfield County: L. J. Horwitz 1 Johnson, C NW NE 4-20n-3w. Dry. TD 4,778 ft. McVay & Stafford 1 Schieber, NE SW NE 12-21n-4w. Dry. TD 3,775 ft.

Grant County: Cummings-McIntyre 1 Blubaugh, SE SW NE 13-27n-6w. Dry. TD 5,653 ft.

Logan County: Lang & Unger 1 Jarred, SW SE SW 25-18n-2w. Dry. TD 5,905 ft.

Noble County: Wilcox-Mikel Drilling Co. 1 Greenshields, SW SW SW 21-24n-2e. Dry. TD 4,566 ft.

Okmulgee County: Welch-Whitehead-Mize 1 Hawkins, NW SW NE 7-12n-13e. IPP 28 BOPD, Booch sand 1,575-1,600 ft., 38°. TD 1,602 (extends Southwest Schulter field).

Osage County: Service Drilling Co. 5 Osage, NE NE SE 12-25n-6e. IrF 579 BOPD, Burbank 2,814-38 ft., 35 BOPD Miss. chat 2,882-91 ft., ¾-in. TD 2,891 ft. (New pay in Northeast Little Chief field).

M. F. Ramsey 1 Osage, SW SW SE 23-26n-5e. Dry. TD 3,055 ft.

Pawnee County: Anchor Petroleum Corp.-Amerada Petroleum Corp. 1 LeFlore, SW SE SE 17-23n-3e. Dry. TD 4,262 ft.

Stephens County: Mack Oil Co. 1 Newman, SE SE SE 26-2s-4w. Dry. TD 7,517 ft.

Schafer Drilling Co. 1 Calloway, C NE NW 6-1n-8w. IPP 9 BOPD, 4,524-28 ft., 29°. TD 6,513 ft. (Extension discovery).

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Type E For Low Pressure . . .

2" to 30" A.G.A. Spec.

Where, except at Robinson, can you obtain all these features in an orifice fitting for gas or liquid flow? Extreme accuracy of measurement is yours because the Robinson orifice is always centered with the piping and sealed against leakage. Orifice plates can be changed safely and quickly (3 to 5 minutes) with no interruption in flow, no hazards or gas loss. Various sizes and pressure ranges up to 3,500 PSI, flanged or welding neck.

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Same fine metering characteristics as the standard low pressure Type E shown above, but built for 6,000 PSI with positive pressure seal which becomes tighter as the pressure increases. Safety is assured because the fitting cannot be opened until the pressure is released. Available in flanged or welding neck. Compare Robinson point-by-point and you'll choose Robinson.

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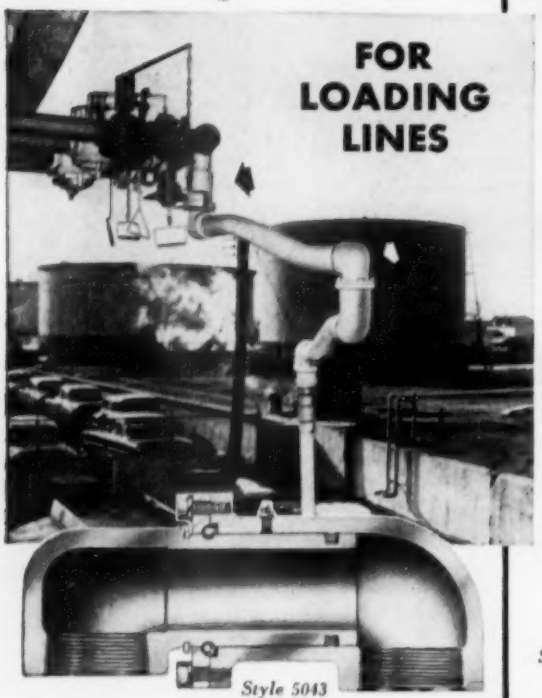

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For complete information on Barco Swing Joints, ask for a copy of Catalog 400.

WILDCAT COMPLETIONS

KANSAS

Barber County: The Chicago Corp.-Armer & Cohen 1 Davis Ranch, C NE NE 11-35s-15w. IPF 32 BOPD, Miss. 4,982-5,003 ft. TD 5,777 ft. (Opens Salt Fork pool).

Bay-Pickrell 1 Dolbow, NE NE NE 13-30s-11w. Dry. TD 4,912 ft.

Butler County: Crest Petro'eum Co. 1 Singer, NW NW SW 36-28s-6e. Dry. TD 2,908 ft.

Clark County: Sinclair Oil & Gas Co. 1 Combrink, C NW SE 22-33s-21w. IP 8,000 M.c.f. of gas per day, Morrow sand 5,318-36, 5,350-60 ft., 1-in. TD 5,463 ft. (gas discovery).

Doniphan County: Gordon Curtis 1 Fraser, NW NW NW 14-2s-19e. Dry. TD 2,280 ft.

Decatur County: Jones, Shelburne & Farmer 1 Eckhart, SE SE SE 3-2s-26w. Dry. TD 3,718 ft.

Ellis County: Veeder Supply 1 Irwin, NW NW NW 11-11s-20w. IPF 1,960 BOPD, Lansing-Kansas City 3,368-80 ft. TD 3,668 ft. (Eagle Creek).

Graham County: Jones, Shelburne & Farmer 1 Hickert "B," SE SE SW 27-6s-25w. Dry. TD 4,256 ft.

Anschutz Drilling Co. 1 Gosselin, SW SW SE 6-8s-21w. Dry. TD 3,693 ft.

Petroleum, Inc. 1 Noah, NW SE NW 33-10s-21w. IPP 103 BOPD, Marmaton 3,756-64 ft. TD 3,830 ft. (Opens Southwest Noah field).

Barnett Drilling Co. et al 1 Griffith, NW NW SW 9-10s-22w. Dry. TD 3,820 ft.

Greenwood County: A. R. Jones 1 Rawlings, C NW 32-22s-12e. Dry. TD 2,552 ft.

Harper County: Gulf Oil Corp. 1 Birchenough, NW NW NW 1-34s-7w. Dry. TD 5,215 ft.

Morris County: C. R. Atkinson et al 1 Peterson, NW NW SE 34-16s-5e. Dry. TD 2,268 ft.

Pawnee County: Musgrove 1-A Johnson, SE SE NW 34-20s-19w. Dry. TD 4,530 ft.

El Dorado 1 Keeley, SE SE NW 9-21s-15w. Dry. TD 3,827 ft.

Todd Drilling Co. 1 Buster, SE SE NE 10-22s-16w. Dry. TD 4,105 ft.

Saline County: D. T. Ingling 1 Weisgerber, SE NE SE 2-16s-1w. Dry. TD 2,671 ft.

Seward County: Northern Pump 1 Satterfield, C NW 13-31s-32w. IP 14,000 M.c.f. of gas per day, Hugoton pay. TD 5,556 ft. (geological wildcat in Hugoton field).

NEBRASKA

Banner County: Wytex & Cosden Petroleum 1 Gifford, C SE SE 8-19n-55w. Dry. TD 5,583 ft.

British-American Oil Producing Co. 1 Stauffer, C NE SW 27-19n-55w. Dry. TD 5,760 ft.

Cheyenne County: F. P. Zoch & New Drilling Co. 1 McKinney, NE NE NE 23-15n-53w. Dry. TD 5,544 ft.

SOUTH DAKOTA

Hyde County: Hornet Oil Co. 1 Aesoph, SE NW SW 2-116n-71w. Dry. TD 2,186 ft. Granite.

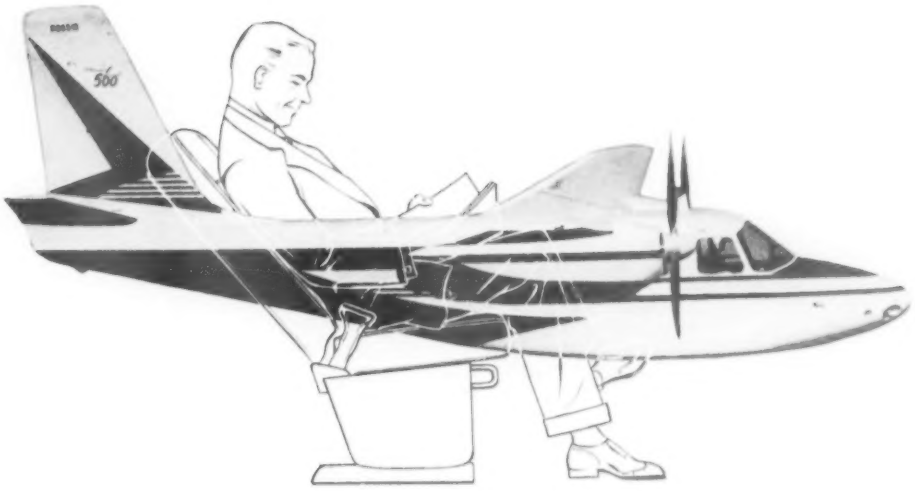
NORTH DAKOTA

Kidder County: Caroline Hunt 1 Sauter estate, NW NE 32-142n-74w. Dry. TD 5,904 ft. Winnipeg.

Sheridan County: Caroline Hunt 1 Pfeiffer, SW SW 16-146n-74w. Dry. TD 6,342 ft. Winnipeg.

Stark County, Belfield area: Amerada Petroleum Co. 1 Newton, C NW SW 31-140n-99w. IPF 6 bbl. oil in 7 hours, Heath

(Continued on page 424)



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Individual chair backs adjust to three comfortable positions.

Chairs adjust fore and aft for added comfort —leg room.

The restful comfort of individual by-the-window seats in the new Aero Commander 560 greatly enhances the pleasure of air travel. Seating comfort is typical of the way in which this 5-7 place twin-engine executive airplane anticipates the exacting requirements of the flying executive.

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AERO DESIGN Commander 560

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Magcobar's NEW FACILITIES

MEAN BETTER MUD

Magcobar's new general offices and laboratories in Houston mean better mud service for you!

Unexcelled research, product development, field service, geological and engineer training laboratories help to make Magcobar's drilling mud service the most complete in the industry.

1. LIBRARY
This new addition to the Research Department, which is available to all other departments, contains reference books on chemistry, chemical engineering, physics, petroleum engineering, and geology.

2. RESEARCH LABORATORIES
Many of Magcobar's new products had their birth in the company's research laboratories. This is one of three labs in constant use in the search for new drilling mud products and additives that will allow more economical, faster and more efficient drilling.

3. FIELD SERVICE LABORATORY
This laboratory stands behind every one of Magcobar's several hundred field service engineers. Here research specialists with extensive field experience are continuously at work on field mud problems.

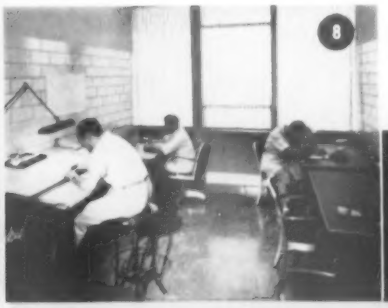
4. RECEPTION LOBBY

5. ACCOUNTING DEPARTMENT
The various phases of accounting and the keeping of company records are handled in the accounting department.

6. ANALYTICAL LABORATORY
This laboratory evaluates production samples to insure that highest possible uniform quality

SERVICE FOR YOU

So Magcobar, the company that was built on good service, high quality and fair and reasonable prices, now offers **better** mud service at **your** rig as a result of continued growth and expansion. Magcobar means the best service in the oil fields.



MAGNET COVE BARIUM CORPORATION
ONE OF THE DRESSER INDUSTRIES
HOUSTON, TEXAS

is maintained in every Magcobar product. The analytical lab also aids the geological office in the evaluation of exploration samples from various localities.

7. ENGINEER TRAINING LABORATORY

As part of their extensive mud training program, Magcobar engineers receive six weeks of concentrated study in all phases of drilling mud testing and servicing. In addition, the mud engineers receive several weeks of field indoctrination followed by a sales training program at Magcobar's headquarters. When these "mud doctors" are finally assigned to the field, they are trained to provide the finest mud service available.

In addition to this laboratory's function as a training area for Magcobar engineers, oil industry personnel are always welcome to take any or all of Magcobar's training course. During the past few years several hundred such people have attended this training school.

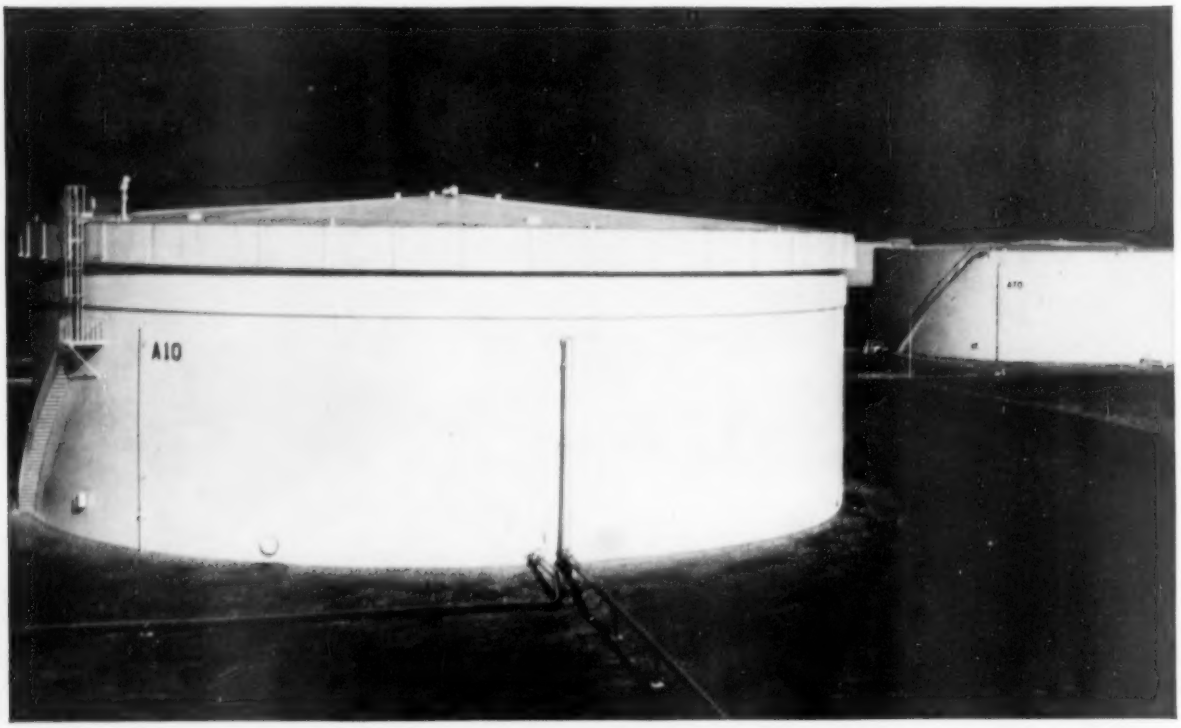
8. GEOLOGICAL SECTION

This office is the headquarters for the men in the geological department who spend the major part of their time in the field searching and testing new deposits to enable Magcobar to maintain adequate high quality raw material supplies for the oil industry in the future.

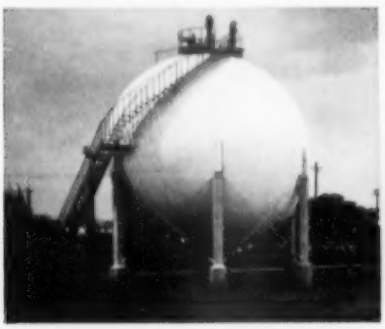
Magcobar
Complete
DRILLING MUD SERVICE

GRAVER CONSERVATION TANKAGE

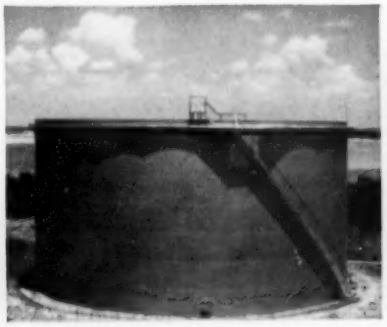
Designed for the Petroleum Industry



The Graver Expansion Roof Tank with its liquid seal *protects under all conditions.* It is ideal for positive control of gasoline vapors against evaporation. Easy to maintain, it eliminates breathing losses and reduces filling losses. It can well protect an entire terminal. It has gained rapid recognition among leading petroleum companies.



GRAVERSPHERES are especially suitable for storage of natural gasolines and other volatile liquids such as butane. They are the ideal answer to gas storage—sustaining pressures up to and exceeding 100 psi.



To prevent the formation of vapors, the GRAVER DOUBLE-DECK FLOATING ROOF is in direct contact with the liquid. This exclusive GRAVER design is widely used at crude and product storage areas, at refineries and pipeline terminals.

The *thrifty* VAPOR-MIZER eliminates standing losses and reduces filling losses. Moreover, less steel is used in building. The VAPOR-MIZER often eliminates the necessity for reinforcing manifolded tanks, since it operates at pressures less than one ounce.

GRAVER TANK & MFG. CO., INC.

East Chicago, Indiana

CHICAGO • NEW YORK • PHILADELPHIA • EDGE MOOR, DEL. • ATLANTA • CATASAUQUA, PA. • PITTSBURGH • CLEVELAND • DETROIT • TULSA
SAND SPRINGS, OKLA. • HOUSTON • ODESSA, TEXAS • CASPER, WYO. • LOS ANGELES • FONTANA, CAL. • SAN FRANCISCO

Haight Promoted

Veteran foreign operator named president of Creole

H W. HAIGHT, newly elected president of Creole Petroleum Corp., feels at home in nearly any of the world's major oil-producing countries.

His oil career stretches over 28 years and three continents, giving him a broad, hard-to-find international background in the petroleum industry. Although born, reared, and educated in the United States, the 52-year-old executive has never held a domestic job in the industry.

Haight decided to seek his fortune in foreign oil fields even before he finished college. During summer vacation in 1926, he went to Mexico where he worked as a junior geologist and as an engineer for a seismograph party.

After getting his degree in geological engineering from Colorado School of Mines, Haight returned to Mexico and joined Cia. Transcontinental de Petroleo, S. A., a Mexican affiliate of Standard Oil Co. (N.J.). Starting as a torsion balance helper in 1927, Haight worked his way up to geologist and acting field superintendent for the Mexican firm.

Goes to Egypt . . . Haight was transferred to Cairo with another Standard affiliate in 1938. There, he moved quickly up the ladder from chief geologist for Standard Oil Co. of Egypt, S. A., to manager, then to chairman and managing director.

After 7 years in Egypt, Haight returned to Latin America. He joined Creole, also a Standard of Jersey affiliate, in 1945 as production manager. He was elected vice president and director the following year, and in 1950 he was made executive vice president, the post he held until his recent promotion.

Diplomat in disguise . . . Harold W. Haight is known in foreign oil fields as a rough, two-fisted operating man who can get things done. But under a sometimes gruff exterior, he has a pleasant personality which has enabled him to maintain friendly relations with dignitaries, some of whom are not distinguished by their devotion to American "intruders."

His present job requires the skill of a diplomat plus the brain of a business executive. During his long experience with the Jersey Standard organization, Haight has fulfilled both requirements. Few men in the industry can match his intimate acquaintance with the sometimes tempermental Latins, and few executives anywhere have his broad knowledge of the problems confronted by international oil operators.

Small-town boy . . . Haight was born July 21, 1902, at Chickasha, Okla., a town currently enjoying one of the most active drilling campaigns in the country. He grew up in New Mexico and attended high school at Tucumcari before entering college at Golden, Colo.

Although Haight has necessarily broken many of his domestic ties during his lengthy overseas service, he is an active member of the American Association of Petroleum Geologists and the American Institute of Mining and Metallurgical Engineers. He was awarded a distinguished achievement medal by Colorado School of Mines 2 years ago.

Haight is married and has one daughter. In his new job he will continue to make his home in Caracas.

A. T. PROUDFIT

Arthur T. Proudfit has been elected to the board of directors of Standard Oil Co. (N. J.). Proudfit has resigned his position as president of Creole Petroleum Corp. to devote his time to his new duties in New York. H. W. Haight has succeeded Proudfit as president of Creole (see Who's Who, above). Proudfit began his petroleum career in 1919 as a tool dresser in Tampico, Mexico, with Huasteca Petroleum Co. He later served with Lago Petroleum Corp., Standard Oil Co. of Argentina, and Standard Oil Co. of Venezuela. When Creole took over Standard of Venezuela, he joined Creole as general manager. In 1944, he was elected vice president of the corporation, and in 1945, he was elected president. **H. A. Jarvis** has been named to succeed Haight as executive vice president of Creole. Jarvis has been with Jersey Standard affiliates since 1930 when he was employed in Esso's Bayway, N. J. refinery as a student engineer.

M. D. King, assistant manager of the products distribution department of Ohio Oil Co., has been promoted to

M. D. KING

L. B. McCAMMON

manager of the department. King succeeds **L. B. McCammon,** former manager of the department, who is retiring after 24 years with Ohio.

Wesley T. Dorsheimer has been promoted to assistant manager of eastern region of E. I. du Pont de Nemours & Co.'s Petroleum Chemicals Division. Dorsheimer replaces **Barry V. Cornwall,** who has been named assistant manager of the Gulf Coast Region.

Elmer H. (Buck) Weaver has been elected a vice president of Union Oil Co. of California. During the past year, Weaver has been on loan to the Government as assistant director of Office of Defense Mobilization in charge of critical materials and stockpiling.

Greg Ireton, of Gulf Oil Corp.'s Fort Worth geological staff, has been promoted to zone subsurface geologist at Fort Worth. Other Gulf promotions include: **R. L. Jones** to petroleum engineer at Judkins, Tex.; **J. B. Netardus** to gasoline-plant engineer at Eunice, N. M.; **H. W. Parker, M. E. Harges,** and **F. H. Hartman** to special staff geologist at Fort Worth; **C. A. Engwall** to zone regional geologist at Midland, Tex.; **W. C. Harrington** to zone subsurface geologist at Midland; **J. W. Balzer, J. M. Sexton,** and **C. O. Greenfield** to junior seismic geophysicist at Fort

PERSONALS

Worth; **J. A. Norwood** to assistant division subsurface geologist at Fort Worth; and **L. D. Jones** to field material supervisor at Andrews, Tex.

Jack M. Balderas, Jr., geologist with Gulf Oil Corp., has been transferred from Billings, Mont., to Tulsa.

Don E. Hibbard, geologist with Seaboard Oil Co., has been transferred from Russellville, Ark., to Denver.

Ben H. King, chemical engineer with The Texas Co., has been transferred from Port Arthur to Amarillo, Tex.

David C. Pontius, Long Beach, and **A. L. Diehl,** Bakersfield, development engineers for Shell Oil Co., have been transferred to the area office in Los Angeles. **P. J. Fazio, F. E. Field,** and **N. E. Methven,** have been promoted to engineers and moved to the company's Ventura division office. **C. J. Miller,** development engineer, has been transferred from the Salt Lake City office to Los Angeles. **W. C. Thompson** has been promoted to district drilling foreman at Salt Lake City. **R. N. Mahan** has been promoted from junior engineer to gas engineer in the Los Angeles office.

Dr. Charles H. Leigh has joined the catalysis section of M. W. Kellogg Co.'s research laboratory at Jersey City.

J. B. Sparks has been named chief geologist for Bell Brothers of Robinson, Ill. Before going with Bell, Sparks was serving as district geologist for Bay Petroleum Corp. at Abilene, Tex.

Bushrod B. Howard has retired as a member of the board of directors of Standard Oil Co. (N. J.) after 34 years with the Jersey organization, nine as a director. Howard was graduated from the U. S. Naval Academy at Annapolis, Md., in 1911. He joined Jersey in 1920 after serving with the Navy throughout World War I.

P. A. Chester, Winnipeg, former vice president, has been elected vice chairman of the board of directors of Hudson's Bay Oil & Gas Co., Ltd. Other promotions made by Hudson's include: **L. J. Richards,** former assistant general manager, elected administrative vice president; **G. H. Bowes,** former manager of exploration, named vice president in charge of exploration; and **F. F. Sellers,** former chief accountant, elected controller and assistant secretary-treasurer.

Charles Eger, geologist with Gulf Oil Corp., has been transferred from Evansville, Ind., to Bismarck, N. D.

Lewis V. Roos, former seismic supervisor with The Texas Co. at Denver, has been named senior seismologist with the company at Houston.

John Norris, formerly a staff geologist in Sunray Oil Corp.'s Midland, Tex., district office, has joined Choya Drilling Co., Midland, as head of the exploration department. Norris worked for Sunray 7 years.

C. C. (Mike) Harter, Jr., formerly vice president and chief geologist of Oil & Gas Property Management, Inc., Dallas, has been elected executive vice president of the company. **Lee J. Thronson,** produtcion manager at Dallas, and **Harry Leyendecker,** superintendent of the firm's Gulf Coast production division at Houston, have been elected vice presidents.

W. A. McMillan has been named assistant general manager of the research and technical department of The Texas Co. Other appointments announced by the department are: **Gus Kaufman,** manager of operations. Research division: **W. J. Coppoc,** manager of research; **T. C. Heisig,** assistant manager of research (products); **C. E. Moser,** assistant manager of research (process). Technical Services division: **R. W. Hall,** manager of technical services; **A. L. Brodie,** assistant manager of technical services (automotive); **M. L. Langworthy,** assistant manager of technical services (manufacturers' service); and **R. R. Thurston,** assistant manager of technical services (industrial products). Beacon, N. Y., laboratories: **C. E. Cummings,** superintendent; **R. L. Sawyer,** director of research; **R. E. Conary,** assistant director of research; and **Bruce Hegeman,** director of technical research. Port Arthur and Port Neches, Tex., laboratories: **C. T. Anne,** superintendent; **H. D. Massin,** director of research. Montebello, Calif., research laboratory: **du Bois Eastman,** director of research. Regional managers: **B. Y. McCarty,** Chicago; **C. E. Emmons,** Los Angeles; and **O. P. Puryear,** Houston. **K. L. Hollister** has been named technical representative for the department in Detroit.

New Officers of West Central Texas Association

Members of West Central Texas Oil and Gas Association recently elected new officers for the coming year. They are, left to right: P. W. (Bill) Pitzer, Jr., independent operator from Breckenridge, president; E. Bruce Street, partner of Ibex Co., Graham, vice president; Thomas S. Cox, independent operator, San Angelo, vice president; and R. C. Grisham, president of Grisham-Hunter Corp., Abilene, vice president. Pitzer succeeds J. C. Hunter, Jr., Abilene.

PERSONALS

Thomas Debevoise has been appointed assistant manager of the eastern division of Peoples Natural Gas Co.

R. E. HOWE

Richard E. Howe has been appointed general manager of Standard - Vacuum Oil Co.'s marine department and coordinator for the company's tanker fleet of 50 vessels, operating in the Eastern Hemisphere. Howe started in the oil industry 21 years ago with Standard Oil Co. (N. J.) in the marine department. **A. J. Vecsey** has been appointed executive assistant general manager of the marine department by Stanvac, and **J. N. Stevens** has been named assistant general manager of the marine department.

Charles W. Stuckey, Jr., Union Oil Co. of California, has been elected president of Society of Economic Paleontologists and Mineralogists. Other officers elected by the group are: **E. H. Rainwater**, Shell Oil Co., vice president; **W. H. Akers,** The California Co., secretary; and **Fred L. Smith, Jr.,** treasurer.

H. B. PETERS

Hallam B. Peters has been appointed chief engineer of the refining department of The Texas Co. Peters succeeds **David W. Carswell,** who has retired after 37 years of service, the last 17 as chief engineer. Peters joined Texaco as a draftsman in 1925 at Port Arthur, Tex., refinery. He moved through several refining assignments before he was named assistant chief engineer of refining department in 1937. **Francis Horton** and **J. C. Neyland, Jr.,** were appointed to serve as assistant chief engineers along with **R. E. Nagle** who continues in the position.

Hugh L. Hemmingway, Pure Oil Co., has been elected president of National Lubricating Grease Institute at its annual meeting in San Francisco. **William M. Murray,** Deep Rock Oil Corp., was elevated to vice president; and the following were named directors: **M. R. Bower,** Standard Oil Co. (Ohio); **A. J. Daniel,** Battenfeld Grease & Oil Corp.; **A. G. Olsen,** Sunland Refining Co.; **F. E. Rosenstiehl,** The Texas Co.; **William H. Saunders, Jr.,** International Lubricating Corp.; and **B. G. Symon,** Shell Oil Co.

Transportation Committeemen Receive Awards

George H. Hill, Jr., vice chairman for Transportation of A.P.I. awarded members of the division of transportation with "certificates of appreciation" for their past work on the committee. Shown receiving the award are left to right: S. S. Smith, Shell Oil Co., (retired); F. B. Hufnagel, Jr., Sun Oil Co.; A. M. Gee, Ohio Oil Co., (retired); Hill, Cities Service Co.; W. F. Jones, Gulf Oil Corp.; A. B. Gorman, Esso Standard Oil Co.; and H. L. McReynolds, Socony-Vacuum Oil Co., (retired).

E. Donald Wilson, assistant manager of Regina exploration district since 1952, has been named a management assistant of western producing division and a member of division management committee by Imperial Oil, Ltd.

Jack Bogrett and **Gene Del Mauro** have joined the geological staff of Forest Oil Corp. in Casper, Wyo. Bogrett was with the California Co., and Del Mauro with Richfield Oil Corp. before joining Forest.

Dr. E. P. Schoch, 83-year-old veteran of 60 years of teaching at University of Texas, has retired. Schoch, a chemical engineer, is widely known throughout the oil industry for his theories on the utilization and conservation of natural gas.

Loren F. Kahle, deputy coordinator of transportation for Standard Oil Co. (N.J.), has been elected president of the Pipe Liners at the club's ninth annual banquet in Chicago last week. **J. L. Burke,** president of Service Pipe Line Co., was elected vice president of the club, and **J. M. Linehan,** president of Mid-Continent Pipe Line Co., was named to the board of directors.

William A. Wilson, geologist with Gulf Oil Corp., has been transferred from Tulsa to Billings, Mont.

James H. Drewelow has rejoined Cities Service Oil Co. at Houston as a subsurface geologist after a tour of duty with the U. S. Army Engineers.

Howard W. Haynes, production engineer with Gulf Refining Co., has been transferred to Centralia, Ill., from Tulsa.

Elwin M. Peacock, Oklahoma City, former geophysicist in the Oklahoma dsitrict for Sohio Petroleum Co., has been transferred by the company to Midland, Tex., as district geophysicist.

W. A. Pegler has been promoted to regional engineer in the engineering and construction department by Atlantic Refining Co. Pegler was district engineer in the same department for Atlantic at Corpus Christi, Tex., before his advancement.

Walter Leonard, president of Leonard Oil, Inc., has been elected president of Michigan Oil and Gas Association for the 1954-55 year. Leonard succeeds **T. Glenn Caley,** Basin Oil Co., Saginaw. Other officers elected are: **E. Allan Morrow,** Roosevelt Oil & Refining Corp., Mt. Pleasant, vice presi-

PERSONALS

dent; **Kurt de Cousser,** Socony-Vacuum Oil Co., Inc., Lansing, and **Hugh D. Crider,** Muskegon Development Co., Muskegon, co-treasurers; and **William Palmer,** secretary.

Thomas C. Wilson, Gulf Oil Corp., has been elected president of Wyoming Geological Society for the 1954-55 year. Other officers named are: **Ken R. Parsons,** Williston Oil & Gas Co., vice president; **John P. Albanese,** Seaboard Oil Co., second vice president; **Lewis E. Beebe,** Continental Oil Co., secretary; and **H. R. van Gilder,** Sohio Petroleum Co., treasurer.

Dr. Cameron H. Caesar has been appointed assistant manager of the research department by Imperial Oil, Ltd. Before his promotion, Caesar served as chief chemist. Other changes announced by Imperial include: **Bruce H. Mackenzie,** former chief engineer of the pipeline division, promoted to assistant manager of pipeline division, transportation and supply department. **Luis Garcia,** former assistant chief engineer, named to succeed Mackenzie as chief engineer; **K. R. Shipley,** formerly of the Winnipeg refinery, named to post of assistant engineer; and **H. B. Trefz,** named manager of Sarnia Products Pipeline Co.

Elmer Brimberry, former geologist in the Bismarck, N. D., office of Ohio Oil Co., has joined Egyptian-American Oil Co. in Egypt.

W. D. (Bill) Chawner, geologist with Carter Oil Co., has been transferred from Bowling Green, Ky., to Carmi, Ill.

J. D. Driskill, Jr., former petroleum engineer with Gulf Oil Corp. at Kilgore, Tex., has been promoted to area petroleum engineer with Gulf Refining Co. at Lafayette, La.

Harry W. Elliott, Jr., has been appointed chief engineer of SACROC Unit at Snyder, Tex. Elliot had had experience with Texas Railroad Commission, Stanley Gill, J. S. Abercrombie Co., Old Ocean Unit in Brazoria County, Texas, and as a petroleum consultant before joining SACROC.

James D. Castner, senior engineer in the Mid-Continent division office of Sohio Petroleum Co., Oklahoma City, has been transferred to the Okmulgee, Okla., area as field superintendent. Other changes announced by Sohio are: **C. E. Armstrong,** former district superintendent of Kansas water flood district, transferred to Okmulgee as district foreman; **Paul Quillin,** engineer, assigned to the Okmulgee area; **P. K. Richards,** assistant foreman, assigned to the Okmulgee area; and **B. B. Lane,** engineer of Kansas water flood district, transferred to Kansas district.

L. E. Lowry, member of the board of directors of Creole Petroleum Corp., has been elected to the executive committee. **H. J. Wright,** manager of the industrial relations department, has been elected to the board of directors.

E. C. Michels has been named superintendent of the products division of the recently organized Cherokee Pipe Line Co. Michels joined Continental Pipe Line Co. in 1950, and in 1952 he was appointed superintendent of Pioneer Pipe Line Co., which is owned 65 per cent by Continental and 35 per cent by Sinclair Pipe Line Co. **James C. Phelps,** former senior office engineer at Ponca City, Okla., for Continental Pipe Line, has been named to succeed Michels in the Pioneer post. Cherokee is owned jointly by Continental Pipe Line and Cities Service Co.

Gulf Coast Society Chooses New Leaders

Gulf Coast Society of Economic Paleontologists and Mineralogists elected its officers for the coming year at the recent fourth annual meeting of Gulf Coast Geological Societies. They are, left to right: E. H. Rainwater, Shell Oil Co., vice president; Fred L. Smith, Jr., independent, treasurer; Charles Stuckey, Union Oil Co. of California, president; and Wilburn H. Akers, The California Co., secretary.

DEATHS

Floyd John Messner, 48, engineer with Richfield Oil Corp., died recently in a Long Beach hospital.

Palmer Ratchford Bonds, 63, Fort Worth oil man, died recently in a Dallas hospital of a heart ailment. He participated in the early development of East Texas field and with R. K. Dillard of Wichita Falls formed Bonds & Dillard Drilling Corp. at Longview in the early 1930's.

John A. Jackson, 59, chief dispatcher for Sinclair Pipe Line Co. at Independence, Kans., died recently in a Hammond, Ind., hospital after suffering a heart attack 4 days earlier. Jackson had been employed by Sinclair for more than 41 years.

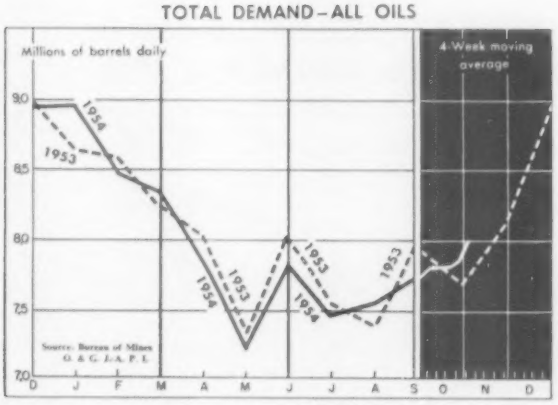
Logan Hart Leggett, 39, gas engineer of Humble Oil & Refining Co., Houston, was accidentally killed in his home recently when a shotgun fell off a shelf and shot him in the neck.

H. M. Lingle, 66, former assistant purchasing agent for Humble Oil & Refining Co., died in Burnet, Tex., recently. Lingle was a past president of of the Houston Purchasing Agents Association. He retired in 1950 after 31 years with the company.

Latest Figures . . . Industry Trends

A QUICK LOOK AT THE HIGHLIGHTS

	LATEST WEEK	Change from WEEK AGO		Change from YEAR AGO	
Production	6,224,825	UP	60,300	DOWN	37,695
Crude stocks	272,185,000	DOWN	1,110,000	DOWN	14,216,000
Completions	1,015	UP	8	DOWN	36
Refinery runs	6,941,000	UP	44,000	DOWN	21,000
Gasoline stocks	149,138,000	DOWN	651,000	UP	7,503,000
Four-product stocks	380,983,000	DOWN	481,000	UP	15,262,000
Total imports	1,141,000	UP	170,400	UP	204,600



Strong Distillate Markets Will Come With the First Long Cold Spell

MARKETERS' experiences with abnormally warm weather for the past two winters have tended to hold distillate prices down during the early months of the current heating season.

Movement out of primary terminals was very heavy in September last year, but the warm weather during the early winter months caused many jobbers to revise their own estimates of needed secondary inventories. The result was a definite sag in the light-fuels market in the last month of the year.

Disappointing sales during two warm winters have tended to make jobbers cautious in buying for the coming season. Also, the movement to jobbers in October and early November may have been influenced by lack of ready cash, since these retailers had a large part of their working capital tied up in accounts receivable.

If the first real winter weather hits about the time consumers are paying their fuel bills, demand will take the big jump that is needed to add real strength in the distillate market.

The extent to which this market is influenced by small changes in the weather is shown by reports of "discounts" from posted prices in the New York Harbor area. A few days of warm weather will bring a crop of rumors of sales at discounts, but these end with the return of lower temperatures.

Barge deliveries of No. 2 fuel in New York Harbor have been posted at 9.35 cents a gallon since early in October or at about the same level as last year. However, the prospects for a firm market in December seem to be better than last year. The low for No. 2 was maintained at 9.4 cents a gallon last year until about the middle of December when it dropped back to 9.25 cents. Slow sales, resulting from warm weather, brought another drop to 9.15 cents early in January, but this was followed by cold weather, increased sales, and higher prices. The low for barge deliveries was up to 9.7 cents before the end of the month.

Pressure on gasoline . . . Gasoline markets are still under the influence of excessive inventories with little chance for relief before next summer.

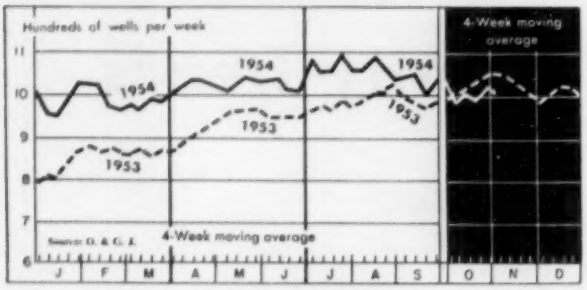
Gasoline price wars continue in many areas, particularly on the East Coast. The small improvement in some New England areas was offset by additional price cutting in New Jersey and on Long Island. As fast as holes in the price levee are plugged, breaks are reported in other areas.

Suppliers may not be able to do much toward lowering the pressure during the winter months, but they can prevent an increase in pressure by a sharp reduction in gasoline yields during the winter months.

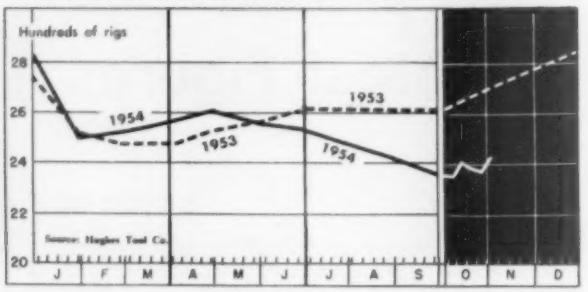
Residual outlook . . . Some discounting off current posting for residual fuel has been reported for the New York Harbor area, but the market is expected to remain fairly stable during the winter months.

Residual is the strongest product on the Group 3 market, but prices of as much as $1.50 a barrel would shift some of the market to other fuels.

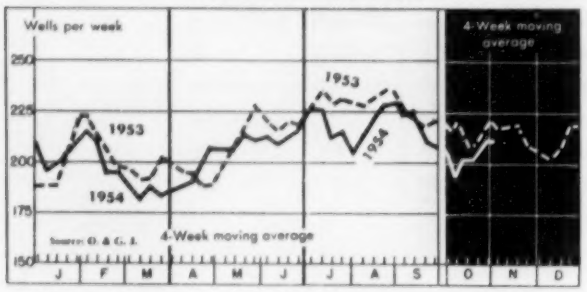
TOTAL COMPLETIONS



ROTARY RIGS OPERATING IN UNITED STATES



WILDCAT COMPLETIONS



ACTIVE ROTARY RIGS

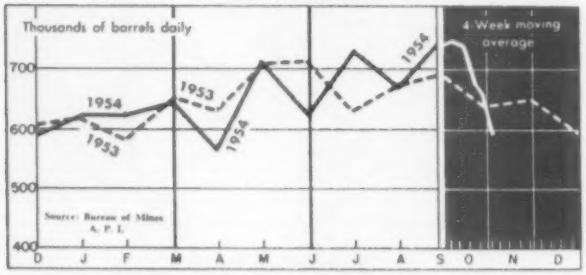
Area—	11-8-54	Change from 11-1-54	Change from 11-9-53
Gulf Coast	528	8	— 57
N. and W. Texas-New Mexico	735	12	—104
Arkansas-N. Louisiana-E. Texas	185	8	— 10
Oklahoma	296	7	— 68
Kansas-S. Nebraska	159	3	— 5
Illinois-Eastern	137	3	— 26
Rocky Mountain	255	14	— 48
Pacific Coast	136	5	— 25
Total United States	2,431	60	—343
Western Canada	191	20	40

WEEKLY WELL COMPLETIONS . . . WEEK ENDED NOVEMBER 6, 1954

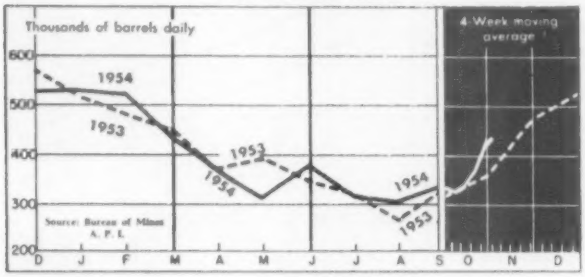
	Total of all wells: Comp.	Oil	Gas	Dry	Footage	Cum. 1954	Cum. 1953	Wildcat completions and discoveries: Oil	Dist.	Gas	Dry	Total	Cumulative total, 1954: Oil	Dist.	Gas	Dry	Total
Ala.-Ga.-Fla.	0	0	0	0	0	90	121	0	0	0	0	0	2	0	2	78	82
Arkansas	8	5	0	3	36,218	549	480	0	0	0	3	3	21	0	4	102	127
California	38	23	1	14	164,789	2,010	2,189	1	0	1	11	13	51	1	12	445	509
Colorado	26	7	4	15	132,403	1,109	608	0	0	2	9	11	29	0	17	462	508
Illinois	69	40	0	29	169,086	2,618	1,734	2	0	0	5	7	20	0	1	360	381
Indiana	12	0	1	11	21,178	679	1,102	0	0	0	4	4	9	0	1	133	143
Kansas	81	40	5	36	291,593	3,857	4,471	3	0	2	14	19	74	0	22	522	618
Kentucky	30	14	3	13	37,146	977	962	0	0	0	5	5	15	0	4	106	125
Louisiana	62	43	6	13	405,082	2,984	2,438	0	3	1	1	5	92	49	34	295	470
North	37	21	5	11	137,725	1,654	1,073	0	0	1	1	2	17	3	13	127	160
South	25	22	1	2	267,357	1,330	1,365	0	3	0	0	3	75	46	21	168	310
Michigan	7	3	1	3	21,225	480	524	1	0	0	3	4	15	0	0	176	191
Mississippi	7	1	0	6	71,806	360	338	0	0	0	2	2	10	1	0	131	142
Montana	22	11	3	8	67,968	290	379	0	0	0	4	4	6	0	2	95	103
Nebraska	5	2	0	3	29,607	370	281	0	0	0	3	3	21	0	3	117	141
New Mexico	17	6	8	3	103,588	920	1,236	1	0	0	1	2	18	1	17	91	127
North Dakota	8	4	0	4	65,058	259	229	1	0	0	3	4	5	0	0	96	101
Ohio	53	20	16	17	114,835	990	942	0	0	0	1	1	3	0	5	14	22
Oklahoma	146	85	5	56	467,828	7,618	6,442	3	0	0	11	14	115	3	21	559	698
Pennsylvania-New York	30	9	10	11	56,543	1,936	1,891	0	0	1	1	2	0	0	7	35	42
Texas	357	212	13	132	1,464,152	15,785	14,697	14	0	0	72	86	665	63	146	3,549	4,423
Southwest (1 & 4)	48	21	2	25	177,321	2,225	2,379	3	0	0	20	23	94	25	38	609	766
Gulf Coast (2 & 3)	52	22	4	26	288,825	2,264	2,163	1	0	0	15	16	69	32	44	569	714
East (5 & 6)	20	10	3	7	104,117	830	687	0	0	0	3	3	17	0	13	241	271
North Central (7-B & 9)	142	79	0	63	406,220	5,975	5,604	5	0	0	27	32	302	4	20	1,439	1,765
West (7-C & 8)	84	74	0	10	452,072	3,654	3,201	4	0	0	6	10	177	0	22	617	816
Panhandle (10)	11	6	4	1	35,597	837	663	1	0	0	1	2	6	2	9	74	91
Utah	4	1	0	3	18,314	74	60	0	0	0	3	3	3	0	1	46	50
West Virginia	14	0	14	0	42,314	521	513	0	0	1	0	1	0	0	31	15	46
Wyoming	16	7	0	9	94,763	1,076	689	0	0	0	2	2	32	0	6	163	201
Miscellaneous (Tenn., S. D.)	3	0	1	2	6,993	108	66	0	0	1	2	3	3	0	1	30	34
Total United States	**1,015**	533	91	391	3,882,489	45,660	42,092	26	3	9	160	**198**	1,209	118	337	7,620	9,284
Total previous week	1,007	545	73	389	4,002,775			20	2	8	176	206	1,183	115	328	7,460	9,086
Total November 7, 1953	1,051	531	82	438	4,184,792			27	1	6	199	233	1,234	91	313	7,853	9,491

Service wells included: Ohio 4, Okla. 1.

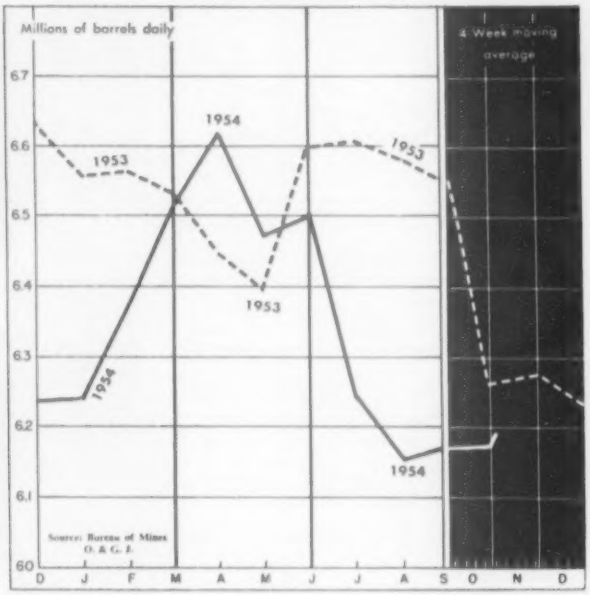
CRUDE IMPORTS



PRODUCT IMPORTS



CRUDE-OIL PRODUCTION

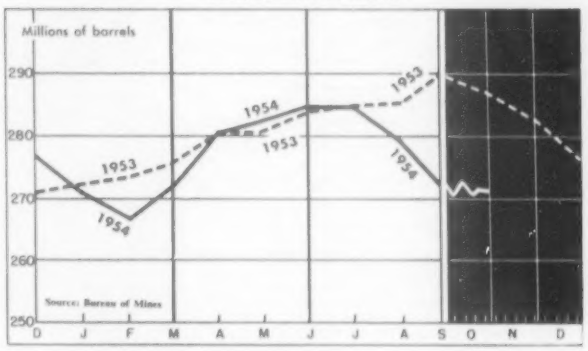


DAILY AVERAGE PRODUCTION FOR WEEK

	November 6 Crude oil	November 6 Lease condensate	November 6 Total	Oct. 30 total
Alabama	4,000		4,000	4,300
Arkansas	71,800	450	72,250	72,500
California	960,900		960,900	960,100
Colorado	136,700		136,700	137,200
Eastern	49,800		49,800	50,000
Florida	1,500		1,500	1,575
Illinois	186,800		186,800	184,400
Indiana	28,600		28,600	27,700
Kansas	316,400		316,400	320,300
Kentucky	37,900		37,900	37,100
Louisiana	586,225	43,600	629,825	624,500
North	101,950	2,600	104,550	105,500
South	484,275	41,000	525,275	519,000
Michigan	32,700		32,700	31,100
Mississippi	89,525	3,850	93,375	91,100
Montana	43,200		43,200	42,700
Nebraska	19,300		19,300	19,200
New Mexico	207,600	2,500	210,100	206,675
North Dakota	17,300		17,300	16,100
Oklahoma	489,400		489,400	483,700
Texas	2,584,500	50,375	2,634,875	2,597,575
Dist. 1	42,825	450	43,275	42,800
Dist. 2	132,000	7,700	139,700	137,050
Dist. 3	405,950	23,750	429,700	421,100
Dist. 4	227,425	5,650	233,075	231,300
Dist. 5	42,850	475	43,325	42,925
Dist. 6	108,925	5,025	113,950	111,600
East Texas field	208,600		208,600	203,800
Dist. 7-B	130,425	25	130,450	134,025
Dist. 7-C	171,725	4,600	176,325	175,600
Dist. 8	840,000	2,025	842,025	822,000
Dist. 9	188,925	625	189,550	188,350
Dist. 10	84,850	50	84,900	87,025
Utah	5,000		5,000	5,200
Wyoming	254,600		254,600	251,200
Others	‡300		‡300	‡300
Total U. S.	6,124,050	100,775	**6,224,825**	6,164,525
Change from previous week,			up **60,300**	
Canada	†278,450		†278,450	†281,250
Total U. S. production January 1-November 6			1,962,703,425 bbl.	
Same period last year (crude plus cond.)			*2,015,648,169 bbl.	

*Includes 28,098,975 bbl. condensate. †Week ended previous Monday. ‡Incl. 100 S. D., 200 Nev.

CRUDE-OIL STOCKS



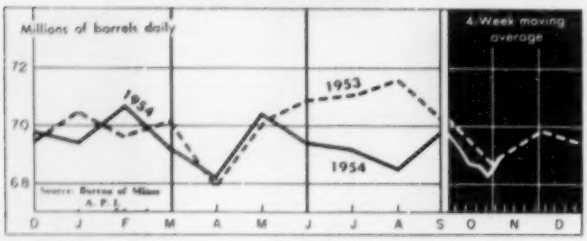
CRUDE-OIL STOCKS BY STATES OF ORIGIN*

(Thousands of barrels)

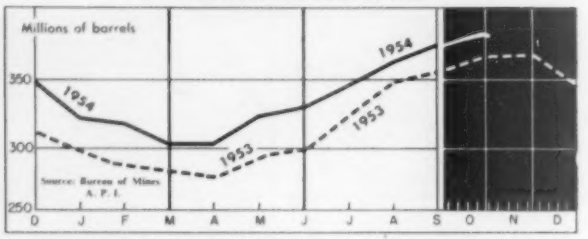
	Oct. 30, '54	Oct. 23, '54	Oct. 31, '53
Pennsylvania Grade	3,210	3,202	2,911
Other Appalachian	1,949	1,843	1,853
Illinois, Indiana, Michigan	12,421	12,706	13,029
Nebraska, N. Dakota	1,971	2,032	(‡)
Kansas	8,556	8,469	9,315
Oklahoma	26,758	26,707	30,435
Arkansas	3,048	3,006	3,420
Louisiana	15,185	14,617	17,060
North	2,500	2,402	3,199
Gulf	12,685	12,215	13,861
Mississippi	3,005	2,948	3,604
New Mexico	8,526	8,376	8,997
Texas	126,259	127,184	134,734
East Texas proper	10,416	10,461	12,350
West Texas	56,617	57,329	60,180
Texas Gulf	24,741	25,144	29,436
Other Texas	34,485	34,250	32,768
Wyoming	13,092	13,123	13,807
Other Rock Mountain	5,705	5,650	3,189
California	32,288	32,261	32,654
Foreign	†10,212	11,171	11,393
Total	272,185	273,295	286,401

*Bureau of Mines. †Includes 2,869,000 bbl. in California. ‡Included with Kansas.

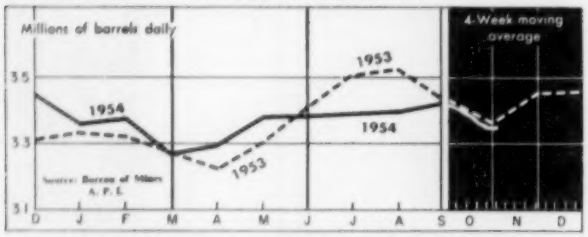
REFINERY RUNS



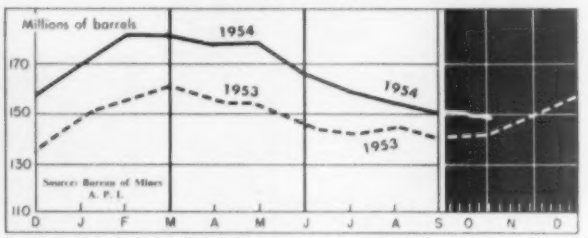
FOUR-PRODUCT STOCKS



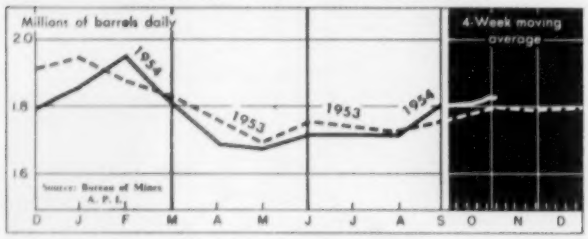
GASOLINE PRODUCTION



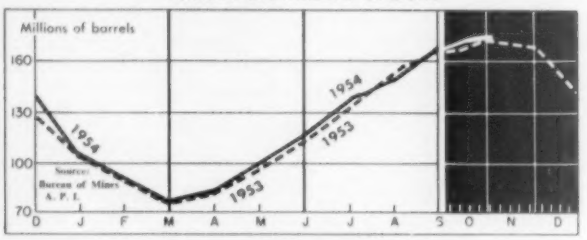
GASOLINE STOCKS



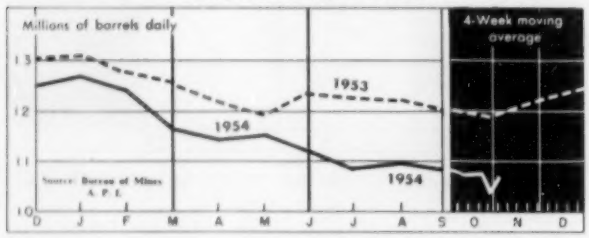
MIDDLE-DISTILLATE PRODUCTION



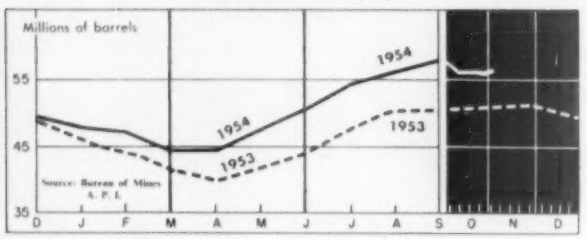
MIDDLE-DISTILLATE STOCKS



RESIDUAL PRODUCTION



RESIDUAL STOCKS



A.P.I. REFINERY REPORT, NOVEMBER 5

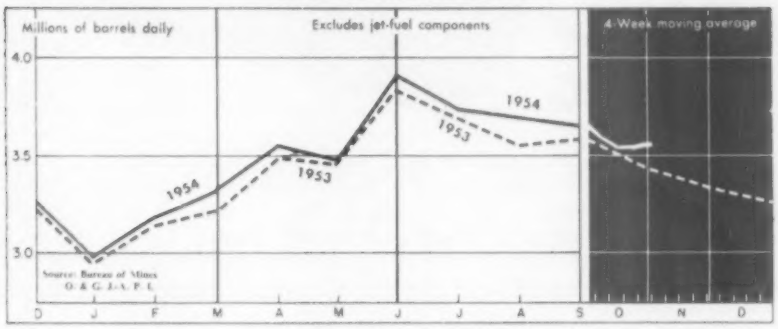
(Excludes all jet-fuel components)

(Thousands of barrels)

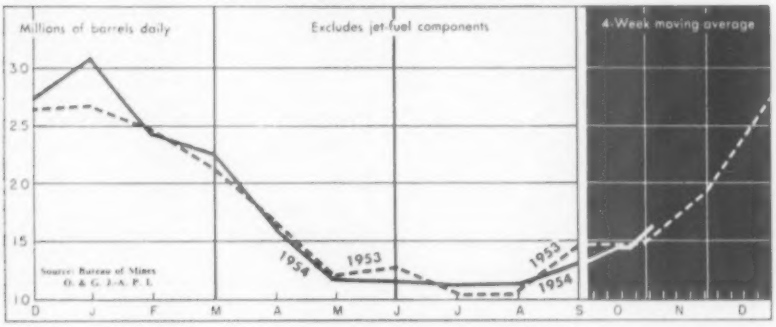
District—	Daily avg. runs	Daily average production Gaso.*	Kero.	Dist.	Resid.	Stocks‡ Gaso.†	Kero.	Dist.	Resid.	Bureau of Mines, November 1953 Daily avg. runs	Daily average production Gaso.*	Kero.	Dist.	Resid.
East Coast	957	431.1	29.0	249.4	164.0	34,263	15,084	52,761	10,896	1,028	436.8	34.4	247.0	217.2
Appalachian:														
District 1	91	34.0	5.8	16.0	3.9	4,406	793	2,984	607	115	51.7	6.5	24.6	12.5
District 2	98	43.0	5.6	18.6	11.3	2,193	478	854	293	88	45.2	5.7	14.5	11.9
Ind., Ill., Ky.	1,254	639.9	84.0	226.6	164.7	32,336	9,899	26,018	4,385	1,336	738.4	79.9	249.5	195.2
Okla., Kans., Mo.	580	341.9	13.0	140.6	33.4	13,280	2,425	13,104	1,321	592	351.3	17.0	133.1	50.3
Inland Texas	240	178.1	7.0	46.9	23.6	5,490	347	2,286	1,313	230	177.7	8.5	42.7	30.9
Texas Gulf Coast	1,800	798.6	134.0	387.3	218.9	20,482	4,486	17,167	5,922	1,692	826.4	123.0	402.2	243.8
La. Gulf Coast	533	293.9	52.0	174.1	46.1	9,235	3,170	4,936	1,292	552	282.8	60.9	124.7	47.0
N. La. and Ark.	89	29.6	7.4	19.0	6.6	4,015	963	1,405	138	88	37.7	8.5	20.1	7.2
Rocky Mountain:														
New Mexico	19	10.4	...	4.0	2.7	207	...	86	31	20	12.5	0.4	3.0	3.6
Other Rocky Mt.	223	95.4	3.0	50.1	29.0	5,018	223	2,317	726	219	112.5	4.8	48.9	38.1
California	1,057	399.7	1.3	143.1	415.7	18,213	310	13,280	29,545	1,027	455.9	4.5	153.1	365.1
November 5, 1954	6,941	3,295.6	342.1	1,475.7	1,119.9	149,138	38,178	137,198	56,469	6,987	3,528.9	354.1	1,463.4	1,222.8
October 29, 1954	6,897	3,418.3	333.6	1,527.0	1,043.6	149,789	38,228	137,055	56,392					
November 7, 1953	6,962	3,280.6	310.6	1,426.0	1,178.9	141,635	37,072	135,678	51,336					

*At refineries including natural blended. †Finished and unfinished. ‡At refineries, bulk terminals, in transit, and in pipe lines.

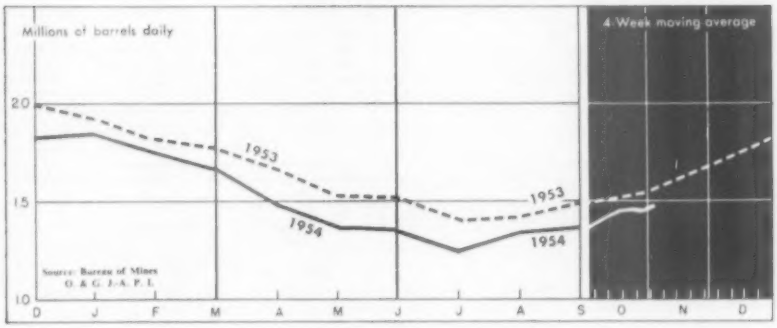
TOTAL GASOLINE DEMAND



TOTAL MIDDLE-DISTILLATE DEMAND



TOTAL RESIDUAL DEMAND



REPRESENTATIVE QUOTATIONS

Spot-market quotations of leading suppliers as of November 10, 1954. Prices are in cents per gallon, except for residual in dollars per barrel and wax in cents per pound.

GASOLINE, KEROSINE, AND FUEL OILS

	Mid-Continent Group 3	New York Harbor (barge)	Texas Gulf Coast
Regular gasoline	10.25-11	11.25-12	10.50-10.75
Premium gasoline	11.25-12	13-13.75	11.50-11.75
42-44 w.w. kerosine	9.125-9.25	10.10	9-9.25
No. 2 straw fuel oil	8.375-8.5	9.35	8.5
No. 6 residual	$1.35-1.40	$2.25-2.35	$1.85-1.95

NATURAL GASOLINE

	Group 3	North Texas	N. La.
Grade 26-70	5.5	5.0	5.25
Grade 18-55	6.6	6.1	6.35

LUBRICATING OILS

Mid-Continent

150-160 vis., D bright stock, 0-10 pp.	18
200 vis., No. 3 neutral, 0-10 pp.	13.25

WAX

Mid-Continent

132-134 A.M.P.	6.0

• Heavy fuel continues as the strongest product on the Group 3 market, but some marketers report that there is a general feeling in the area that prices will not be pushed above about $1.40 or $1.45 a barrel despite the lack of surplus material.

PRODUCTION AND DEMAND—MAJOR PRODUCTS

(Thousands of barrels daily)

	Refinery prod.	Total demand
Gasoline:		
Four weeks ended 11-5-54	3,340	3,546
August 1954	3,391	3,649
October 1953	3,359	3,423
November 1953	3,444	3,330
Middle distillate:		
Four weeks ended 11-5-54	1,832	1,651
August 1954	1,755	1,173
October 1953	1,795	1,479
November 1953	1,785	1,926
Residual fuel:		
Four weeks ended 11-5-54	1,075	1,479
August 1954	1,069	1,272
October 1953	1,184	1,521
November 1953	1,223	1,654

CRUDE PRICES

GRAVITY SCHEDULE

	Signal Hill, Calif.*	Oklahoma, Kansas	Gulf Coast Tex.†	West Tex.‡
14-14.9	$1.87			
15-15.9	1.93			
16-16.9	1.99			
17-17.9	2.05			
18-18.9	2.11			
19-19.9	2.18			
20-20.9	2.24	$2.50		$2.37
21-21.9	2.30	2.52		2.39
22-22.9	2.37	2.54		2.41
23-23.9	2.45	2.56		2.43
24-24.9	2.53	2.58	$2.91	2.45
25-25.9	2.61	2.60	2.93	2.47
26-26.9	2.69	2.62	2.95	2.49
27-27.9	2.76	2.64	2.97	2.51
28-28.9	2.83	2.66	2.99	2.53
29-29.9	2.91	2.68	3.01	2.55
30-30.9	2.97	2.70	3.03	2.57
31-31.9	3.04	2.72	3.05	2.59
32-32.9	3.12	2.74	3.07	2.61
33-33.9		2.76	3.09	2.63
34-34.9		2.78	3.11	2.65
35-35.9		2.80	3.13	2.67
36-36.9		2.82	3.15	2.69
37-37.9		2.84	3.17	2.71
38-38.9		2.86	3.19	2.73
39-39.9		2.88	3.21	2.75
40 and above		2.90	3.23	2.77

*Standard Oil Co. of California. †Upper Texas Gulf Coast. ‡Includes New Mexico Permian.

Effective dates: California, February 16, 1953; east of California, June 15, 1953; Pennsylvania Grade, September 1, 1954.

FLAT CRUDE PRICES

Representative posted schedules per barrel.

Louisiana:	
Cotton Valley (distillate)	$3.00
Cotton Valley (Holloway crude)	2.95
Texas:	
East Texas	2.90
Chapel Hill	2.83
Conroe	3.13
Van	2.73
Pennsylvania Grade:	
Bradford	3.23
Middle District	3.15
Southwest Pennsylvania	2.81
West Virginia	2.70
Ohio	2.74
Illinois Basin	2.90-2.95-3.02

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FOR SALE: Approximately 100,000'—1' 1.7# 5,000# Test Continuousweld Line Pipe, originally ordered for Kobe installations. Contact R. H. Coe, our Midland office, for direction to location our Spraberry Camp, or write Purchasing Agent, Tide Water Associated Oil Company, Box 731, Tulsa 2, Oklahoma.

1—MODEL RL 3-Drum Cardwell Powered with Buda Model 844D Diesel Engine. Rig and Engine in Perfect Condition. 1-87' 2-Pole Mast. Box H-404, The Oil and Gas Journal, Tulsa, Oklahoma.

2500 FT. FAILING rotary rig available for contract work. Production, slim hole, or cleanout. Rig and drill pipe A-1. Contact M & G Drilling Co., 1102 East St., Iola, Kansas. Phone 1979.

Gaso Duplex 4½" x 6" Power Pumps with Chrysler C-36 Engines, skid mounted, immediate delivery. Also Byron Jackson, Carter Centrifugal Units. Westinghouse 20-25-50 KW Generating Units.

H. H. COFFIELD
Attn.: W. H. ORR
Phones: 132—Rockdale, Texas
AT-3427—Houston, Texas

GASOLINE PLANT *FOR SALE*

Gasoline Plant, located in Brazoria County, Texas, shut down in January 1954. Had been processing approximately thirty-three million feet of gas daily with absorber pressure approximately six hundred thirty pounds. Plant recovered Propane, Butane, Gasoline, Kerosene and Diesel Oil. Adequate storage tanks for all products. Drum Lead Blending Plant. Detailed inventory available upon request.

SOUTHERN PRODUCTION CO., INC.
P. O. Box 670, Ft. Worth, Texas

USED EQUIPMENT

Franks East Texas Unit, mounted on K-10 International Truck. Located in Seminole area.

Franks SAL 4160 Skid Rotary Rig Cummins Power, 96' Derrick. Located, Tulsa, Oklahoma.

O.C.S. Type 3 Servicing Unit mounted on 1942 Mack Truck. Located Odessa, Texas.

Write, Wire or Call

FRANKS MFG. CORPORATION
Box 3218, Whittier Station
Tulsa, Oklahoma

FOR SALE EQUIPMENT

FOR SALE: ENGINE—165 Hp. Climax Model R61, maximum continuous Hp. rating 126 Herndon Drilling Company, 421 Mayo Building, Tulsa, Phone 4-9700.

FOR SALE—15 Tank Cars 10,000 gal. insulated coiled Class III. Also 8—8000 gal. Darien Corp. 60 E. 42nd, N. Y., N. Y.

VINYL-COATED NYLON TARPAULINS. Water-proof, rot-proof, fire-proof, oil resistant, durable, seam-sealed. The Neilroy Company, exclusive distributor. 1526 E. Admiral, Tulsa, Oklahoma.

FOR SALE
WILSON MOGUL 42 ROADARE

Fully equipped with 5000' Grade D & E Drill Pipe, Seven 6¼" Drill Collars, 96' Heavy Duty Mast, F X Z 7¼" x 12" Gardner-Denver Pump, Two WAKDU Waukesha Motors and Miscellaneous Equipment to make complete Drilling Rig. Purchased February 1st, 1953, and Drilled 166,124' of Hole. 1000' above Drill Pipe used on one well. Equipped to Drill 5000'. For Details Contact:

NORTHERN PUMP COMPANY
Chas. J. Beu, Box 94, Telephone 7817, Great Bend, Kansas

or—**NORTHERN PUMP COMPANY**
Telephone SUNSET 8-8601, Minneapolis, Minnesota

FOR SALE EQUIPMENT

FOR SALE—Near Gladewater, dismantled 1 National G-100 geared pumping power complete with 100 HP. Superior Type BT Twin Cylinder 2 Cyl. gas engine and companion material, $1500.00. Contact O. C. Brown, Gladewater office, or Patridge, Cities Service Oil Company, Bartlesville.

FOR SALE—NUMBER ONE CONDITION

25,000'—Std. 4" Line Pipe, Machine Cleaned & Bevelled, 20 ft. Random lengths.
7,500'—7" O.D. Lapweld Casing, 20#, T&C
300'—X-Hvy 8⅝" O.D., ½" Wall
This is good, used, material—priced right

STANDARD PIPE & SUPPLY COMPANY
3211 Main St. RI-1217 Dallas, Texas

FOR SALE
WILSON SUPER MODEL WINCH

with Rotary drive and cathead, powered by a 140 GKU Waukesha. Unit is mounted on an LF-170 International tandem with an 8⅝" x 7" x 65' demountable, double pole mast. Complete with tools and equipment for servicing wells to 10,000 feet or drilling to 3,000 feet.

M & R SPECIALTY CO., INC.
2500 Holmes Road, Houston, Texas.
Telephone LY-2666

REFINERY UNITS FOR SALE

1—Foster Wheeler 8000 Bbl. per day Two Stage Atmospheric & Vacuum Unit. Six side Streams.
2—Texas Company BK Unit 1800 Bbl. per day solvent paraffin extraction plant.
3—Chlorex Unit 1000 Bbl. per day solvent Asphalt extraction plant.
4—Badger Rerun Unit 2000 Bbl. per day.
5—Kellogg Rerun Unit 3000 Bbl. per day.
6—Percolation Filter Plant 2000 Bbl. per day.
Each of the above plants complete from suction of charge pumps to flange of run down tanks.
Includes Furnaces, Towers, Condensing and Cooling Equipment, Instruments, Controls, Regulators, Piping, Pumps, Motors, Turbines, Receivers and Tube and Shell Heat Exchangers. All equipment in excellent condition.
Three Hundred Tanks 200 to 80,000 Bbls.
Four Hundred Pumps, Duplex steam drive, also Steam Turbine and Motor drive.
8—750 H.P. Babcock & Wilcox Water Tube Cross drum Boilers 200 # W.P. Feed Pumps and Compressors.
3—Steam Turbine 1500, 1000 and 750 KVA complete with Generators, Panel board, Exciters.
Steam jets, Surface Condensers, Barometric Condenser.
Five Thousand valves ½" to 12"
Fifty mile of pipe ½" to 12"
1000 Steam Traps
Large Quantity of Caning equipment, Clay handling equipment, Machine Shop Equipment.
3—2000 G.P.M. Atmospheric red wood cooling Towers, 96' x 12' x 30' high.

Your personal inspection invited, your inquiry requested.

C. J. Simpson Drilling Company

Attn. Allen Peairs, Phone 9219 and 2-0125,
P. O. Box 139, Olean, New York

FOR SALE EQUIPMENT

FOR SALE—New drilling line—11,000 feet —6x19—type U Bethlehem improved plow steel—left lay—5,000 feet—1" dia.—6,000 feet —⅞" dia.—Also 1—used Kerotest—6x7—drilling through valve and 1—used Kerotest well head assembly. Contact M. M. Hudson, South Penn Oil Company, Bradford, Pennsylvania.

FOR SALE: 564 ft. of 10" casing, in A-1 condition. Price $1500.00. Contact Duke & Wood Drilling Co., Great Bend, Kansas.

FOR SALE 5000' RIG: 1 250 Bethlehem complete drilling rig less derrick and drill pipe. Compound with two D-13000 Cats and 14 inch Bethlehem pump. Located: Wampler Bros., Box 1987, Longview, Texas. Phone PL 92312.

FOR SALE: Three type 80 Cooper Gas Engine Compressors completely rebuilt. Two type 80 Cooper Compressors as is. One 100 H.P. Superior as is or rebuilt. One Clark 100 H.P. Gas Engine driven Compressor. W. S. Smith, 205 Thompson Bldg., Tulsa, Okla.

CORE DRILLS—Acker Model for 150' coring $1855. Acker Model for 350' coring $2715. Acker Model for 800' coring $5410. Everything for well drilling. S. W. Pressey & Son., Pueblo, Colo.

ELLIOTT Centrifugal Blower, 14,000 cfm, size 48-A, Type "O," single stage, 2.25 psi, 125 hp Motor. Excellent condition. Refinery Materials Co., Box 14306, Houston.

THREE #12 Sweetland Filters, 48 bronze leaves, monel covered, on 3" C.C., now located in southwest, available for inspection. 11 Sperry 18" x 18" cast iron Filter presses, 11 chambers. Consolidated Products Co. Inc. #65 Garden Street, Hoboken, N. J. N. Y. Tel.: BArclay 7-0600.

SAVE $2385 EACH—New Waukesha Engines. 3 Waukesha NKU's—less power take offs. Price at Wichita, $5052 each. Save $2657 Each—New Murphy Engines. 4 Murphy 122's—less power take-offs. Price at Wichita, $6301 each. Save $1817 Each—New Caterpillar Engines. 4 Caterpillar D-13000—less power take-offs. Price at Wichita, $4252 each. Save $301 Each—New Buda Engines. 4 Buda 6MO-970—less power take-offs. Price at Wichita, $3073 each. Cardwell Mfg. Co., Inc., 801 So. Wichita. Wichita, Kansas, Phone LD-128.

FOR SALE: 5500 ft. Trailer Rig with 7¼" x 14" Gardner-Denver pump, 5" x 10" Gardner-Denver Pump, 5000' of 3½" Drill Pipe, Light Plants, Bunk House and all other necessary equipment to make up complete drilling rig. Perfect Condition. For inventory and price write to Box H-504, The Oil and Gas Journal, Tulsa, Oklahoma.

Stop Tong Breakage!

ARMITE DRILL COLLAR & TOOL JOINT COMPOUND

ARMITE LABS., 6809 Broad St., Los Angeles 1, Calif
Petro. Industries Consultants, C.A. Caracas, Venez.

FOR SALE

53 Million Cubic Feet Capacity Dehydration Unit (NEW AS SHIPPED FROM FACTORY)

One complete BS&B Glycol Dehydration Unit—Regenerative equipment is skid-mounted and the two contractors are externally piped, requiring minimum labor for field erection. Dew point depression of 65° guaranteed by BS&B when handling 53 MMCF per day or less when inlet gas saturated with water vapor at 80° F. and 800 lb. psig. Maximum working pressure 1000 lbs. psig. Glycol carry-over loss guaranteed by BS&B not to exceed 0.1 gallons per million feet when operated at capacity.

Price 80% of cost,
f.o.b. Woodlawn, Texas

Woodlawn Processing Corporation
P. O. Box 4128, Centenary Station
Shreveport, Louisiana

FOR SALE EQUIPMENT

COMPLETE RIG: New U-15 Drawworks with four 250 Horse Power Cummins diesel engines through hydraulic couplings, hydromatic brakes on 127-foot 450,000-lb. Lee C. Moore mast and substructure, 8,000 Ft. 4½" Drill Pipe, 14 new 7" O.D. x 2⅞" Bore Drill Collars, new Emsco D-500 7½" x 16" pump, new Cameron twin hydraulic BOP, and all accessories. Good condition. Now drilling 8,000-ft. well in Rocky Mountain area. Inventory on request. Box H-403, The Oil and Gas Journal, Tulsa, Oklahoma.

SALES and rentals of cable drilling and fishing tools, casing and equipment, from the Southwest's largest stock of used cable tools and oil field supplies. Degen Pipe and Supply Co., Tulsa, Oklahoma.

FOR SALE: Sullivan 200 complete with all tools ready to work. Located Tulsa, Okla. Contact R. F. Mesker, Phone 6-0057 or 5-9357, Tulsa.

U-15 WITH hydromatic brakes, powered by four 250 Horse Power Cummins diesel engines through hydraulic couplings with 127' Lee C. Moore mast, 4½" drill pipe, 6¼" drill collars. Oilwell 14P pump, mechanical Shaffer double BOP and all accessories for complete rig. First class operating condition. Rocky Mountains. Inventory on request. Box H-405, The Oil and Gas Journal, Tulsa, Oklahoma.

LIKE NEW—Model FL-704 Double Drum Cardwell Spudder, complete with 145-GK Waukesha, 55-foot double leg mast, complete 5- and 7-inch tools, tubing and rod tools. Rig only 15 months old and in excellent condition. A real buy at a bargain price. Located Russell, Kansas. Contact C. Spitzfaden—LD-128 or 62-6037, Wichita, Kansas.

GAS METERS. Westcott and Foxboro orifice meters and controllers. Bristol recording pressure gauges. Geo. R. Milner, Box 124, Okmulgee, Oklahoma.

FRANKS MODEL 5000—$7,500: 1-Cummins HBI-600 engine in good condition equipped with spudding attachment, skid and 65' double leg (8⅝ x 7" legs) mast. Call Amherst 73311 Wichita, or write P. O. Box 2001, Wichita, Kansas.

GAS COMPRESSORS: XOB I-R's, 90 h.p. Superiors, Type 80 Coopers, Type X Bessemers and Twin Clarks. Extra Cylinders. Alfred B. Kern, 227 Wright Building, Tulsa 3, Oklahoma.

FOR SALE: 3600' 4½" extra hole drill pipe, good for shallow drilling, $.90 per foot. Terms. Melton Supply Company, Box 1360, Seminole, Okla.

WANT EQUIPMENT: Did you find the equipment you wish to purchase in this column? If not, use an "Equipment Wanted" classified advertisement to find it. It is available somewhere and Journal classified advertisements will find it. See box heading for classified rates, or write The Oil and Gas Journal.

EQUIPMENT WANTED

CASH FOR 28 or 36L Erie-Bucyrus with tools in good condition. Phone 72-4533 or P. O. Box 26, Tulsa.

WANTED—good used 4½", 20#, drill pipe. Give location, quantity and price—Sharp Drilling Company, Box 1271, Midland, Texas.

WANTED TO BUY: Fifteen hundred foot mounted rotary drilling rig from owner who wants to sell, for cash, must be complete and in good working condition. N. C. Dunn, Arkansas City, Kansas. Phone 1668.

EQUIPMENT NOT IN USE: Did you find a buyer in this column for the equipment you have for sale. Someone wants it and an "Equipment For Sale" classified advertisement in the Journal will find a buyer. See box heading for classified rates or write The Oil and Gas Journal.

WE PAY THE MOST for Used Line pipe, used casing, abandoned leases. Gore Oil Field Supplies. Box 1063, Tulsa, Okla.

WANTED
Engines and Compressors

Used Cooper-Bessemer JS 8, LS or LSV units, 1,000 H.P. or over.

Used Cooper-Bessemer GMV 10, GMW or M-Line Compressors.

Box H-480, The Oil and Gas Journal, Tulsa, Oklahoma

EQUIPMENT WANTED

WILL PAY highest prices for used casing, used line pipe, abandoned leases, or other surplus lease equipment. Your idle producing equipment is worth dollars. Green Pipe & Supply Co., Box 1383, Tulsa, Oklahoma.

HELP WANTED

CHEMICAL OR MECHANICAL Engineer, under 35, for responsible position in Alabama Asphalt Refinery. Process or maintenance experience desired. This is good opportunity with established independent. Box H-491, The Oil and Gas Journal, Tulsa, Oklahoma.

SUBSURFACE GEOLOGIST
Opening with independent oil company for graduate subsurface geologist with good working experience in Oklahoma and Kansas. Major oil company experience preferred; must be under 35. Will do geological mapping, drafting, lease evaluations, screening deal submittals, etc. Give complete summary of experience, education and qualifications in reply. Box H-502, The Oil and Gas Journal, Tulsa, Oklahoma.

SUPERINTENDENT—35 to 55 years of age, for Asphalt Division of large independent Mid-Western refiner. Minimum of ten years asphalt experience required. Good salary and fine opportunity for advancement for right man. Box H-492, The Oil and Gas Journal, Tulsa, Oklahoma.

PETROLEUM ENGINEER

Independent drilling and production company has opening for young graduate petroleum engineer specializing in drilling techniques and machinery. Must have field experience in Mid-Continent area, preferably drilling. Will work as assistant to Manager of Operations. Good personality essential, age limit under 35. Give complete qualifications and education in reply.

BOX H-498,
THE OIL AND GAS JOURNAL,
TULSA, OKLA.

PETROLEUM ENGINEER

Major Oil Company in Venezuela has opening for graduate engineer (P.E. or Ch.E) with minimum 3 yrs. oil field exp., preferably in production engineering.

Extensive experience in chemical phases of production such as corrosion and scale control, salt water disposal by reinjection desired.

Write giving full details to:

P. O. Box #35, Bowling Green Station
New York 4, New York

PETROLEUM ENGINEERS

Experienced graduate engineers or recent graduates, for immediate and future job openings in Saudi Arabia and New York City. For engineering work in development, production, drilling, process, and oil and gas engineering on primary and secondary recovery problems.

Salaries commensurate with education and experience. Write giving full particulars regarding personal history and work experience. Please include telephone number.

Recruiting Supervisor, Box 79

ARABIAN AMERICAN OIL CO.
505 Park Avenue, New York 22, N. Y.

HELP WANTED

ENGINEERS—Nationwide organization serving Oil, Gas, and Petrochemical industries has openings for several young men with engineering background, looking for small organization which promotes individual development and advancement. Offices in Chicago, Dallas, Los Angeles, Tulsa and New York. Work involves some travel. Prefer men with two to five years experience. Salary open, all replies confidential. Box H-511, The Oil and Gas Journal, Tulsa, Oklahoma.

PHYSICAL CHEMIST or Physicist, Continental Oil Company, Ponca City, Oklahoma. Immediate opening for physical chemist or physicist. Advanced degree, Ph.D. preferred. Research work in Petrophysics group, Production Research Division. New laboratory building. Excellent benefits and working conditions. Address letter giving education, experience and salary requirement to Personnel Records Division, Continental Oil Company, Ponca City, Oklahoma.

WANTED: By an independent oil company, a graduate Petroleum Engineer with varied experience in secondary recovery operations in the Tri-State area. Please give full particulars of experience and salary expected in the first reply. Box H-510, The Oil and Gas Journal, Tulsa, Oklahoma.

PATENT AGENT, Engineering Degree required, (ChE preferred). Excellent opportunity for an engineering graduate with some experience in patent work, or a man with engineering experience currently attending law school in the evenings. Permanent position providing a career with an internationally known engineering organization in New York City. The salary is good, and the employee benefits are unusually liberal. Our personnel know of this ad; all replies will be treated confidentially. Please send complete details and state initial salary requirements. Box 2499, Room 1201, 230 West 41 St., New York 36, N. Y.

THE RIGHT MAN: Can you fill the position you have open from the qualifications listed in this column. Men are always looking for an opportunity to improve themselves. Use a "Help Wanted" Journal classified advertisement to find the men you need. See box heading for classified rates or write The Oil and Gas Journal.

REFINERY ENGINEERS

for MAJOR OIL COMPANY

Several openings for Chemical, Mechanical and Civil Engineers in the following fields:

- Process Design
- Refinery Technical Service
- Product Quality Control & Development
- Refinery Design and Project Engineering
- General Engineering of Refining Plants
- Refinery Utilities Engineering

Candidates should meet the following requirements:

- 3 or more years experience in any of above listed fields.
- Draft exempt.
- Interested in possibility of future overseas service.
- Bachelor's or Master's degree in Engineering from recognized technical college or university.

Salary commensurate with background and experience. Complete employee benefits plans.

Send detailed resume to:

BOX H-503,

THE OIL AND GAS JOURNAL, TULSA, OKLAHOMA.

PUBLIC ACCOUNTING SERVICE

EDMOND F. GEARY

CERTIFIED PUBLIC ACCOUNTANT

ANNOUNCES THE OPENING OF OFFICES

IN THE NATIONAL BANK OF COMMERCE BUILDING

TULSA, OKLAHOMA

TELEPHONE 5-9355

OCTOBER 1954 SUITE 710

HELP WANTED

GAS ENGINEER—Under 30. Engineering Degree with oil or gas experience. Permanent employment with large gas company. Beginning salary under $500. Box H-509, The Oil and Gas Journal, Tulsa, Oklahoma.

FOREIGN EMPLOYMENT. List of oil companies and drilling contractors showing where to apply for foreign jobs. OIML Co., Box 2603, Tulsa, Okla. $5.00 cash.

WANTED: Manufacturers representatives with good following calling on Oil Producers and Supply Stores to represent Manufacturer of the Hunter Flex-Seal oil well pump plunger and packing means for same. Wants Commission Sales Representatives for following territories: Kansas, Arkansas and North Louisiana, East Texas, West Texas, and California. Please give details concerning present Sales Coverage first letter. All replies confidential. W. H. Hunter Engineering Company, 150 Marlborough Dr., Pontiac 19, Michigan.

DESIGN ENGINEER

Grad. Petroleum or M.E. for oil tool design. Under 30. Three years field and/or design experience. Salary commensurate with background. Write giving complete resume of education, work experience and personal history. Replies will be held in confidence. Company located in Los Angeles area.

Box H-499, The Oil and Gas Journal, Tulsa, Oklahoma.

PETROLEUM ENGINEER REQUIRED BY

Consumers' Co-operative Refineries Limited, Saskatchewan

Minimum requirements: Engineering Degree; at least 3 years proven experience in drilling and production work.

Duties Include: Production and reservoir engineering; preparation and supervision of drilling and production workover programs.

Headquarters—Saskatoon. Staff benefits include: Super-annuation, Medical Benefits, Group Insurance, etc.

Reply stating salary required, date available, etc. to

Manager, Personnel Division,
Saskatchewan Federated Co-operatives Limited
211 Avenue D North
Saskatoon, Saskatchewan, Canada

SITUATIONS WANTED

DESIRE POSITION in sales or office manager. 6 years experience in these lines with major supply company. Box H-508, The Oil and Gas Journal, Tulsa, Oklahoma.

GEOLOGIST, B.S., single, 4½ yrs. experience, 1 yr. Texas, 3½ yrs. Four Corners area in drilling, exploration, production of natural gas wells. Desires position with small independent. Box 542, Farmington, New Mexico.

SITUATIONS WANTED

GEOLOGIST—10 years experience Texas, Louisiana, Oklahoma, Kansas, Nebraska, in well supervision, evaluation, appraisal, reports, record checking. Desires connection with progressive individual or small company. Will locate anywhere domestic. Box H-494, The Oil and Gas Journal, Tulsa, Oklahoma.

REFINERY ENGINEER. Experienced in maintenance supervision, design and construction of fluid and T.C.C. Units, Cat Poly, platforming and thermal cracking units and their auxiliaries. Age 31. Box H-507, The Oil and Gas Journal, Tulsa, Oklahoma.

REGISTERED PETROLEUM ENGINEER Extensive water flood experience with major and independent companies. Diversified primary drilling, producing, reservoir evaluation, unitization, production research, lease acquisition-supervisory and management. Desire position with aggressive company. Box H-481, The Oil and Gas Journal, Tulsa, Oklahoma.

ENGINEERING EXECUTIVE—Ch.E., more than 15 years diversified supervisory experience in Process Design, Engineering and Operation. Desires connection with company in/or serving petroleum refinery or petrochemicals industry. Degrees. Box H-500, The Oil and Gas Journal, Tulsa, Oklahoma.

CONSTRUCTION SUPERINTENDENT: twenty years experience, Industrial plants, Sewer treatment plants, pumping stations all types. M.E. Degree. Qualified to take full responsibility of projects. Cost conscious, know men and equipment, will consider Foreign work, with Major engineer-constructors. Available immediately. Box H-495, The Oil and Gas Journal, Tulsa, Oklahoma.

THE POSITION YOU WANT: Oil Industry companies are looking for men to fill every conceivable kind of position. If you didn't find the position in this column that you are looking for, use a "Situation Wanted" classified advertisement to state your qualifications. Some company is probably looking for your ability. See box heading for classified rates or write The Oil and Gas Journal.

Well organized, well established oilwell drilling contractor desires the management and supervision of oil properties in West Texas, Central Texas, and New Mexico. Can provide complete handling of oil properties, from acquisition to production. No properties too small, and none too large to handle. Inquiries from independents, groups, small or medium sized oil companies invited.

Write, wire, or call collect for further information.

MAKIN DRILLING COMPANY

P. O. Box 1628, Hobbs, New Mexico,
Phone 3-3141.

146 Allen Building, Midland, Texas,
Phone 2-2962.

SITUATIONS WANTED

DRILLING & PRODUCTION Supt., available, 20 yrs. experience Oil & Gas, 43 yrs. of age, married, sober, best of reference. Box H-505, The Oil and Gas Journal, Tulsa, Oklahoma.

GEOLOGIST: 29; Single; B.S. plus graduate studies; 18 months well site geologist, 18 months in geophysics. Desire position in exploration geology—domestic or foreign. Box H-506, The Oil and Gas Journal, Tulsa, Oklahoma.

ROYALTIES

WISH TO BUY producing royalties. Box H-379, The Oil and Gas Journal, Tulsa, Oklahoma.

JACK EAGLE, Oil Properties, 706 City Nat'l. Bldg., Oklahoma City, Oklahoma, Telephone REgent 6-7027.

OFFERING CHOICE PRODUCING oil income royalties with large reserves per Dollar investments. A. S. Berry, 817 Wright Bldg., Tulsa, Okla.

GET TOGETHER: Both Capital and Royalties are available. If the investment proposition you want isn't listed in this column, use a Journal classified advertisement to find it. See box heading for classified rates, or write The Oil and Gas Journal.

LEASE AND DRILLING BLOCKS

DRILLING TO commence on known and proved acreage in producing oil field. This is not a wildcat or an off-set. It's on a known structure with adequate acreage to be profitable. Interest's available at reasonable costs. One half of the cost can be charged off Taxes. Box H-501, The Oil and Gas Journal, Tulsa, Oklahoma.

1120 ACRES for Oil and Gas development, located near Oxford, Kansas, less than one mile of settled production. Box 654, Winfield, Kansas, phone 60.

HAVE SEVERAL large drilling blocks, either for sale or to be drilled. Nothing under 10,000 acres. Two of these blocks are in the hottest county in New Mexico. Tomahawk Oil & Drilling Company, 112 8th St., N.W., Albuquerque, N. M.

QUICK CASH for producing Royalties, production, or over-rides. Consider drilling blocks. Robert L. Kinkaid, P. O. Box 26, Tulsa.

SEE A. L. BOWLES, Box 947, Ada, Okla., for drilling deals and producing royalties if you have the cash for Oil Investments.

Will pay cash instantly for lease (large blocks), royalties, mineral deeds, production. Write fully—P. O. Box 2153, Denver, Colorado.

WILL BUY ⅛ interest in ⅞ drill deal on dry hole basis. Must be good. Geo., Texas, Okla., New Mexico, Wyoming. Box 22, Emmaus, Pa.

LOOKING FOR A LEASE? There will be over 40,000 wells drilled this year. If you are looking for a lease, drilling block, or drilling deal and you haven't found it in this column, or if you have a lease or drilling block you want drilled, a Journal classified advertisement can find an interested party. See box heading for classified rates, or write The Oil and Gas Journal.

LEASES ROYALTIES

Producing and Nonproducing
Bought and Sold—Any Area

Inquiries Invited

B. D. BUCKLEY

6635 Delmar Ave., St. Louis, Mo.

OIL PRODUCTION

We have several producing oil properties for sale in Texas. Shallow depths. Will deal only with principals.

Box H-496, The Oil and Gas Journal, Tulsa, Oklahoma

WANTED

DRILLING DEALS, reasonably priced, with complete, substantiated data for development by experienced group. Box 231, Scarsdale, N. Y.

SOIL ANALYSIS

SOIL ANALYSIS—fascinating new business. Do it yourself, write for details. Surface Oil Surveys, 1414 Electric Bldg., Fort Worth, Texas.

AT LAST, the secret of soil analysis in hunting for oil may be yours. Free details. Surfac Oil Surveys, 1414 Electric Bldg., Fort Worth, Texas.

REAL ESTATE

FOR LEASE—Complete 12 unit trailer camp, facilities to handle 19 man crew, includes power plant, water system, fuel storage. Cities Service Oil, Allen, Bartlesville, Oklahoma.

SPACE IS NEEDED: A Journal display classified advertisement is the quickest way to rent or sell your real estate. In the present period of expansion oil industry firms urgently need the space you have available. If it isn't listed here, you may also find it by stating your needs in these pages. For classified rates see box heading or write The Oil and Gas Journal.

BUSINESS OPPORTUNITY

WILL MERGE GOING royalty company or accept associate with cash to expand. A. S. Berry, 817 Wright Bldg., Tulsa, Oklahoma.

WANTED

STRIPPER WELLS, low lifting cost and substantial reserves, any number, wanted by experienced operator, reasonable. Box H-487, The Oil and Gas Journal, Tulsa, Oklahoma.

LEADING OIL equipment manufacturer wants ideas and new or improved equipment for Refining, Pipeline, Producing or Marketing Divisions. Will acquire small or medium size companies. Our Research Department, manufacturing facilities, capital, management and nationwide sales force are well established and will buy or develop patents or work on royalty or profit sharing basis. Box H-488, The Oil and Gas Journal, Tulsa, Oklahoma.

STRIP LOG CABINETS

MORE LOGS ARE FILED in Kraftbilt Strip Log Cabinets than all others combined! Loaded drawers glide smoothly on roller bearings. Three drawers to section—add sections as needed. Built to last a lifetime! Send for Catalog 352-B. Ross-Martin Co., P. O. Box 800-A, Tulsa 1, Okla.

MAP CABINETS

END MAP-FILING WORRIES FOREVER! **Kraftbilt Rollfiles keep rolled maps safe from dust, dampness, pilferers. Used by all major and hundreds of smaller oil companies.** Send for Catalog 352-B. Ross-Martin Co., P. O. Box 800-A, Tulsa, Okla.

BUSINESS SERVICE

Delaware Corporations formed and serviced. American Guaranty & Trust Company, P. O. Box 487, Wilmington, Delaware.

GIFTS

EXCLUSIVE hand embroidered OIL DERRICK Neckties in attractive poplin—green, blue, yellow, maroon, brown, red. $2.75 each; $15.00 in lots of six—Cash, check or money order. Allow 15 days for delivery. Eleson Fabric Shop, 875 Broadway, Bowling Green, Ky.

LEGAL

SEALED BIDS will be received until 10:00 A. M., Central Standard Time, December 7, 1954, and opened at that time in the office of the Superintendent of the Turtle Mountain Consolidated Indian Agency, Belcourt, North Dakota, for the leasing of 4,273.84 acres of Tribal land and 13,772.24 acres of allotted Indian land, located in Township 162 North, Range 71 West, 5th P. M., Rolette County, North Dakota, for oil and gas mining purposes. The details of the lease offering and how and where to file bids may be obtained by addressing an inquiry to the Superintendent of the Turtle Mountain Consolidated Indian Agency, Belcourt, North Dakota, or by a call to telephone No. 6742, Rolla, North Dakota.

Equipment Men

Scovill Places Corrosion Consultant In Gulf Coast

L. O. Hartzell has recently moved to Houston where he will serve the Gulf Coast area as representative of the technical service and research department of Scovill Manufacturing Co., Waterbury, Conn. Hartzell's duties will consist of helping companies in the petrochemical, refining, utilities, and gasoline-plant industries with nonferrous condenser and heat-exchanger corrosion problems. Selection of proper alloys to withstand various types of corrosive conditions will be included.

Hartzell has formerly been engaged for 10 years in chemical process engineering on the Pacific Coast; 2 years at Hanford Atomic Energy plant with General Electric Co.; and 3 years in the U. S. Navy as steam-engineering officer.

Hartzell will work in conjunction with Baldwin Co., Houston, and Allied Tube Corp., Beaumont, Tex., distributors for Scovill's nonferrous condenser tubes.

National's Engine Division Shifts Two Sales Engineers

Two sales engineers for the engine division of a National Supply Co. have been assigned to new territories.

D. C. Vick, who formerly made his headquarters at Springfield, Ohio, has been transferred to Lincoln, Neb., assisting J. A. Dye, and will cover Nebraska, Kansas, and parts of other midwestern states.

R. A. McCloskey, who formerly worked with Vick in covering Ohio, Indiana, Illinois, and Michigan, is now working in Ohio, Kentucky, West Virginia, and the southern part of Indiana, while National Supply's engine distributor, R. B. Richardson Co., takes charge of the Michigan territory. McCloskey will make his headquarters at Springfield.

Bethlehem Announces Personnel Changes

Bethlehem Supply Co. has announced several personnel changes in the Oklahoma district.

J. W. Jillson has been promoted to machinery sales representative for the

entire Oklahoma district. J. A. Buland has been advanced to local representative in the Oklahoma City district sales office, replacing Jillson. J. W. Strickland has been transferred to Fort Morgan, Colo., in the capacity of a field representative and will operate a substore at that point in conjunction with the Sterling, Colo., store.

Jillson has been employed by Bethlehem since 1947 in the West Texas-New Mexico area, and since January 1953 has been local representative in the Oklahoma City district sales office. In his new capacity, he will concentrate his efforts on both produtcion and drilling-machinery sales.

Prior to his promotion, Buland served as field representative in the Oklahoma City store.

Strickland has been employed by Bethlehem for 7 years and since October 1949 worked as store manager at Elk City, Okla.

WILDCAT COMPLETIONS

(Continued from page 406)

discovery, new field. TD 9,577 ft. Madison.

Sun Oil Co. 1 Beaudoin, NW SW 9-138n-99w. Dry. TD 9,656 ft. Lodgepole. Temp. abd.

CALIFORNIA

Colusa County: Humble Oil & Refining Co. 3 F. J. Steidlmayer, SE SE 3-15n-1w, IPF 1,700 M.c.f. gas daily, ⅜-in. choke, perfs. 1,378-1,415 ft., TD 2,093 ft. (New field discovery in North Colusa area.)

Kern County: Hancock Oil Co. 34A M J M & M-C.C.M.O., 24-25s-18e. Dry. TD 921 ft.

Honolulu Oil Corp. 6 Watson-C.W.O.D., 22-30s-21e. Dry. Point of Rocks 2,560 ft., TD 2,593 ft.

Union Oil Co. 16-26 Reserve-Union, 26-11n-19w. Dry. TD 6,946 ft.

Kings County: E. L. Knotts 4 Avenal, 35-23s-17e. Dry. TD 987 ft.

Los Angeles County: C. W. Teater-Wadley, SW NE 25-3n-16w. IPP 50 BOPD, 21.8° gravity, perfs. 2,530-2,765 ft., TD 2,766 ft. (New field discovery 2 miles east of Aliso Canyon field.)

Orange County: Shell Oil Co. K Core, 16-3s-9w. Dry. TD 5,001 ft.

Riverside County: Pethybridge & Erlich 1 Wright, 33-3s-7w. Dry. TD 4,027 ft.

San Bernardino County: Argyle Campbell & Co. 1 "Well," 26-1s-7w. Dry. TD 1,455 ft.

San Luis Obispo County: Intex Oil Co. 62 Kuhnle, 12-26s-12e. Dry. Vaqueros 5,965 ft., TD 6,010 ft.

Tulare County: J. F. Wilcox 1 Wilcox-Hinkel, 33-19s-26e. Dry. TD 1,293 ft.

Ventura County: R. S. Lytle, Operator 1 Williams, 33-3n-19w. Dry. TD 8,500 ft.

Union Oil Co. 26 Simi, 7-3n-17w. Dry. TD 8,420 ft.

MONTANA

Cascade County, Griffen area: Petroleum Producers & Refiners 1-A Griffen, SW SW SW 12-18n-4e. Shut down. TD 2,405 ft. Jefferson.

1 Colby, C E½ SE NE 29-16n-3e. Temp. suspended. TD 860 ft. Madison.

Roosevelt County, Manning Lake: Mobil Producing Co. F-33-23-P Damm, NW SE 23-29n-54e. Dry. TD 11,890 ft. Red River.

Yellowstone County, Laurel area: Jensen & Sollars 1 Kohl, NW SE NE 35-2s-24e. Dry. TD 999 ft.

UTAH

Boxelder County, Desert Range: Gulf Oil Corp. 1 Williams-Federal, C NW NW 14-6n-16w. Dry. TD 2,894 ft.

Grand County, Courthouse: Equity Oil Co. 1 Donohue-Strat, C NE NE 20-23s-19e. Dry. TD 6,500 ft.

San Pete County, Gunnison: Gunnison Oil Co. 1 Government, NW NW NE 3-19s-1e. Dry. TD 1,780 ft.

WYOMING

Lincoln County, LaBarge: Torgeson Oil Co. 1 McGinnis, C N½ NE NW 27-26n-113w. Dry. TD 3,518 ft. Hillard.

Natrona County, Southeast Tisdale: Hancock Oil Co. 1 State, SE SE SE 16-39n-80w. Dry. TD 3,985 ft. Alcova.

COLORADO

LaPlata County: Continental Oil Co. 1 North Barker Dome, SE NE SW 24-33n-14w. Dry. TD 3,675 ft. Morrison.

Logan County: Miracle & Fifer 1 Segelke, C NE NW 31-6n-54w. Dry. TD 5,076 ft.

Shell Oil Co. 689-1 State, C NW SW 22-7n-52w. Dry. TD 4,691 ft.

Sterling Drilling Co. 1 Smith, NE NE NE 28-11n-54w. Dry. TD 5,360 ft.

Strain Drilling Co. 1 State, SE SE SE 30-8n-51w. Dry. TD 4,682 ft.

Vaughey & Vaughey 1 Peavy-Sprague, C SE NW 17-11n-55w. Dry. TD 5,782 ft.

Morgan County: Braden & Hoover 1 Glenn "B," NW NW SE 9-1n-57w. Shut in gas well. TD 5,492 ft. "J" sand gas discovery, new field.

Sanford Producing 1 Atkinson, SW SW SW 10-2n-55w. IP 5,500 M.c.f. of gas per day, "D" sand discovery, new field. TD 5,061 ft.

Montezuma County, Cortez: Locke Taylor 1 Dixon, NE NE NW 10-36n-14w. Dry. TD 3,450 ft.

Washington County: Braden, Hoover & Kejr 1 Tunnison, C NW NW 3-5n-52w. Dry. TD 4,787 ft.

Weld County: Houser Drilling Co. 1 Doty, NW NW NW 2-7n-59w. Dry. TD 6,738 ft.

SASKATCHEWAN

Canada Southern-Shell 16-20 Clayton, LSD 16, 20-3-22w3. Dry. TD 4,708 ft.

Imperial-Hudson's Bay-Royalite 1-2-5-1 Auburnton, LSD 1, 2-5-1w2. Dry. TD 5,140 ft.

Seaboard 3-29 Devils Lake, LSD 3, 29-28-4w2. Dry. TD 1,650 ft.

Stanolind 1 Rabbit Creek Crown, LSD 15, 10-58-20w3. Dry. TD 3,784 ft.

Canadian-Delhi-Hudson's Bay-Richfield 1 Bone Creek, LSD 6, 34-10-19w3. Shaunavon oil well. TD 4,458 ft.

Phillips-Husky 1 Denehurst, LSD 1, 14-30-21w3. Dry. TD 2,732 ft.

Imperial-Tide Water 7-14-26-11 Gordon, LSD 7, 14-26-17w2. Dry. TD 1,962 ft.

Shell A13-32 Abbott, LSD 13, 32-7-18w2. Dry. TD 5,330 ft.

ALBERTA

Union 16-27 Cecil, LSD 16, 27-13-13w4. Dry. TD 3,285 ft.

Cal-Standard 7 Grassy Island Lake, LSD 6, 22-33-8w4. Dry. TD 2,988 ft.

New British-U. S. Smelting 11-10 Pakowki, LSD 11, 10-5-9w4. Abandoned. TD 2,310 ft.

Northern Development 1-23 L. P. Mann, LSD 1, 23-56-22w4. Viking gas well. TD 3,458 ft.

Calvan 7-5 Hand Hills, LSD 7, 5-29-14w4. Dry. TD 3,850 ft.

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LEGAL

On December 7, 1954 at 3:00 o'clock P. M., Central Standard Time, in the School Auditorium of the Turtle Mountain Consolidated Indian Agency, Belcourt, North Dakota, the following described tracts of Government owned lands comprising 173.71 acres, more or less, located within Township 162 North, Range 71 West, 5th P. M., Rolette County, North Dakota, will be offered for bids at public auction for leasing for oil and gas mining purposes:

Tract No.	Description	Acreage
1-G	$SE\frac{1}{4}$ $SW\frac{1}{4}$, Lots 8 and 9 Sec. 3,	133.40
2-G	$S\frac{1}{2}$ $SW\frac{1}{4}$ $NE\frac{1}{4}$ $NW\frac{1}{4}$, $E\frac{1}{2}$ $NE\frac{1}{4}$ $SW\frac{1}{4}$ $NW\frac{1}{4}$, $SE\frac{1}{4}$ $SE\frac{1}{4}$ $NW\frac{1}{4}$ $NW\frac{1}{4}$, $NW\frac{1}{4}$ $SE\frac{1}{4}$ $NW\frac{1}{4}$, Sec. 8	22.50
3-G	$NW\frac{1}{4}$ $SW\frac{1}{4}$ $NW\frac{1}{4}$, Sec. 25	10.00
4-G	$E\frac{1}{2}$ $E\frac{1}{2}$ $SE\frac{1}{4}$ $NE\frac{1}{4}$ $SW\frac{1}{4}$, $E\frac{1}{2}$ $E\frac{1}{2}$ $W\frac{1}{2}$ $E\frac{1}{2}$ $SE\frac{1}{4}$ $NE\frac{1}{4}$ $SW\frac{1}{4}$, $SE\frac{1}{4}$ $SE\frac{1}{4}$ $NE\frac{1}{4}$ $NE\frac{1}{4}$ $SW\frac{1}{4}$, $E\frac{1}{2}$ $E\frac{1}{2}$ $SW\frac{1}{4}$ $SE\frac{1}{4}$ $NE\frac{1}{4}$ $NE\frac{1}{4}$ $SW\frac{1}{4}$, $W\frac{1}{2}$ $W\frac{1}{2}$ $SW\frac{1}{4}$ $NW\frac{1}{4}$ $SE\frac{1}{4}$, $W\frac{1}{2}$ $W\frac{1}{2}$ $E\frac{1}{2}$ $W\frac{1}{2}$ $SW\frac{1}{4}$ $NW\frac{1}{4}$ $SE\frac{1}{4}$, $SW\frac{1}{4}$ $SW\frac{1}{4}$ $NW\frac{1}{4}$ $NW\frac{1}{4}$ $SE\frac{1}{4}$, $W\frac{1}{2}$ $W\frac{1}{2}$ $SE\frac{1}{4}$ $SW\frac{1}{4}$ $NW\frac{1}{4}$ $NW\frac{1}{4}$ $SE\frac{1}{4}$, all in Sec. 29.	7.81

The details of the lease offering and the conditions may be obtained by addressing an inquiry to the Superintendent of the Turtle Mountain Consolidated Indian Agency, Belcourt, North Dakota, or by a call to telephone No. 6742, Rolla, North Dakota.

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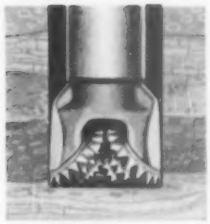

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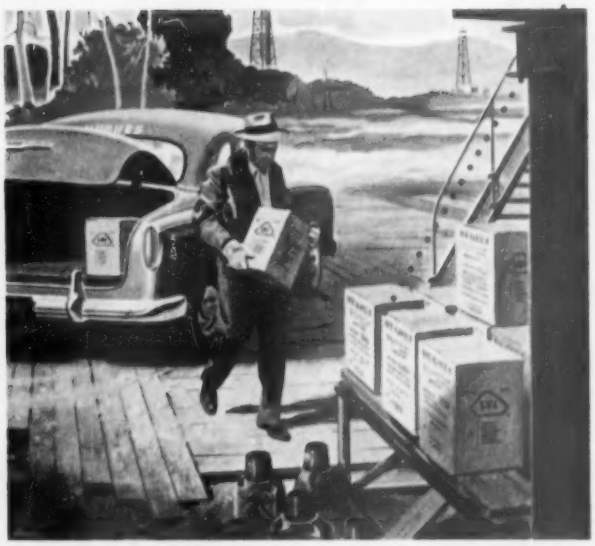

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